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SYMPOSIUM :
LEARNING PROCESSES AND STRATEGIES—I

Editorial Introduction

THE VERB ' TO LEARN ' TAKES THE ACCUSATIVE

AT one time it was common to remind student teachers that the verb ' to teach ' takes two accusatives—you teach someone something. Then the main point was to force subject specialists to recognise that the learner was an important part of the teaching process. The research studies which are brought together within this symposium contain a modern-day reminder to psychologists that the verb ' to learn ' has a subject, the learner, *and* an object—what is to be learned, which, in real life, has complex characteristics of its own. Since the pioneer work of Bartlett (1932) on remembering, there has been a tendency to trivialise human learning in experiments designed to discover fundamental general principles. The content of learning has been controlled, certainly, and experimental designs have been tight and, within their own limits, have produced important findings. But the *control* of stimuli in learning experiments has taken the theories away from the complex content of learning which is the main concern of teachers and educators. The fundamental principles of stimulus-response learning have not helped teachers much. Their limitations have been obvious, but until recently, alternative models have not been available. The criticisms of McKeachie (1974) and the emphasis of the cognitive psychologists on the importance of meaningful learning (Ausubel, 1968; Bruner, 1973), point to a reawakening of interest in problems of more direct relevance to the teacher.

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Recent developments in cognitive psychology have been described by Broadbent (1975). Within the information processing models of human memory and thinking (e.g., Lindsay and Norman, 1972) is an alternative conceptualisation of human learning which at least breaks away from simple associative views of the learning process. These models provide ideas about how humans build up concept networks and how information may be ' filed ' in, and retrieved from, long-term memory. The ideas are still perhaps restricted by an emphasis on simple perceptual inputs and on rule-governed performance of skills, but the models do permit a more direct link with teaching situations than was possible in previous theories (Entwistle and Hounsell, 1975). Information processing theory does, however, still rest on experimental evidence far removed from academic situations.

It has been left to curriculum theorists (Snelbecker, 1974) to build connections between the way content should be structured and the learning processes of students. Some of the instructional theories developed out of the ideas of cognitive psychologists may provide important insights for teachers (Gagné, 1974), but there is still a gap in empirical research on learning in relation to complex materials. Conventional approaches to the study of learning have created a mental set or ' frame ' which has limited views on learning to rather narrow horizons. To break with this tradition carries with it the risk of engendering misunderstanding and deep suspicion. It is not a step to be undertaken lightly. However, in the past few years two research groups have been publishing the results of distinctively different experimental studies of learning. One of these, under Gordon Pask in London, has concentrated on developing apparatus with which to trace how students work their way through academic topics. The theory of 'conversations' (*not* to be confused with conservation) in learning, which has emerged from this work, has involved the development of a new terminology and a redefinition of old terms, which provides formidable problems for the newcomer (Pask, 1975). And yet any theory which has come to grips with the problem of analysing complex areas of knowledge into heuristics which can lead to rapid and almost errorless learning, must surely command respect. In his article Pask describes the way in which Piagetian experiments can be developed, with the help of the computer, into a system within which the student 'talks' himself (as an internal conversation and an interaction with the computer) through a network of concepts and relationships towards a practical demonstration of his understanding of an academic topic.

One can only sympathise with the task of trying to present the fruits of many years research initially within the space of a single summary article and marvel at the way in which ideas from epistemology, Piagetian research, learning theory, instructional science and computer technology are brought together within 'conversational theory.' But how do you evaluate such a theory, especially when its illustrations depend on a knowledge of the complex material being learned by the student (mechanics, biology, statistics) as well as the basic concepts of such a wide range of fields contained within the theory ?

The other research group, under Ference Marton in Gothenburg, has taken a quite different line—one which is deceptively simple in contrast to Pask's, but which nevertheless demands the ability to break out of the 'frame' of previous approaches to learning. Again, the centrality of content in human learning in schools or universities is recognised, but a more humanistic methodology has been adopted and the underlying theory demands an acceptance of the essential uniqueness of each student's attempt at learning under *uncontrolled* conditions. Marton (1975) is also concerned about the failure of many students to appreciate that academic work is rooted in reality, in most subject areas. An inability to discern links with reality, and the tendency to concentrate on the words in a book or to indulge in blind question-spotting rather than looking for the underlying meaning intended by the author or the lecturer, leads to ineffective learning strategies which may have far-reaching educational consequences.

The research procedure adopted by Marton involves asking students how they set about reading a chapter from a text-book, as well as finding out how well their understanding of the ideas in that chapter tallies with the intentions of the author. Perhaps we are moving towards Plato in recognising that what people come to understand is not reality itself, but the flickering and distorted shadows of reality treated by our own limitations. Even if a theorist, or a saint, sees an important truth, his ability to communicate that truth will be distorted by the formal symbolism with which he tries to pass on his ideas. Those who try to understand the ideas are themselves limited by preconceptions, attitudes and incomplete previous knowledge. It seems an intriguing research idea to investigate the qualitative differences between the ways different students come to understand, or misunderstand, what they read.

One other important aspect of Marton's research is that it points up the other strong 'frame' which limits our ability to think imaginatively about learning. The formal educational system defines learning in its own characteristic, and again rather narrow, way. Our examination systems may, in fact, be encouraging those ineffective learning strategies, which lead the student to rely on the surface structure of language and the regurgitation of facts, rather than on ways of coming to understand important ideas and relationships. This theory of qualitative differences in learning seems to carry with it important implications for educators, and the methodology is one which could be followed by teachers and lecturers in relation to their own subject area.

The final paper in the symposium is a research note which lies between the traditional approaches to learning and the studies of Pask and Marton. Michael Howe, in Exeter, has conducted a series of studies in recent years into problems associated with students' learning (i.e., Howe, 1974, 1975). The present article examines one of the mainsprings of conventional learning theory—the effects of engaging in two similar tasks in close succession. Retroactive interference has been identified in some experimental settings, but the findings from meaningful verbal learning have been equivocal. In the laboratory, with limited time available, the effects produced will be slight, unless the experimental condition is accentuated. Howe shows that retroactive interference can be demonstrated in meaningful verbal learning. His study also indicates the possibility of extending the traditions of experimental research so as to bring it closer to the concerns of the practitioner.

In future research into the learning processes of students, there could well be fruitful developments both of traditional experimental research and of alternative approaches. Whether or not the ideas and research methods of Pask and Marton become widely accepted, they do provide an opportunity for a reappraisal of current research into learning. Teachers have been expecting psychologists to provide helpful answers to the broad question of how pupils or students learn. To date psychologists, like adept politicians, have given answers to different, narrower, questions. The research reported in this symposium suggests that although research into realistically complex human learning in natural settings involves immense methodological problems, the combination of conventional and unconventional strategies, and of experimental and field studies, may provide the opportunity of a major breakthrough. It is a challenge which deserves a sustained research effort in response.

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ON QUALITATIVE DIFFERENCES IN LEARNING: I—OUTCOME AND PROCESS*

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SUMMARY. This paper describes an attempt to identify different levels of processing of information among groups of Swedish university students who were asked to read substantial passages of prose. Students were asked questions about the meaning of the passages and also about how they set about reading the passages. This approach allows processes and strategies of learning to be examined, as well as the outcomes in terms of what is understood and remembered. The starting point of this research was that learning has to be described in terms of its content. From this point differences in *what* is learned, rather than differences in *how much* is learned, are described. It was found that in each study a number of categories (levels of outcome) containing basically different conceptions of the content of the learning task could be identified. The corresponding differences in level of processing are described in terms of whether the learner is engaged in *surface-level* or *deep-level processing*.

INTRODUCTION

IN research on the psychology of learning the outcome of learning is commonly described in quantitative terms as a total number of correct answers to a test. Similarly intra- and inter-individual differences and differences which result from experimental manipulation are normally merely referred to as variations in the number of correct answers obtained. In a recently completed research project concerning learning at university level we found a great deal of evidence of the inadequacy of the traditional method of describing the outcomes of learning. Both for instructional purposes and for the understanding of 'what it takes to learn,' a description of *what* the students learn is preferable to the description of *how much* they learn. We have repeatedly found examples of distinctive qualitative differences in how students grasped or comprehended ideas and principles, which were presented in their set books or in texts of a similar kind used as material for learning in experimental settings.

In our view a prerequisite for an analysis of *what is learned* is that one must take into account *the content* of the learning task or the discourse. This is necessary since our main interest is to describe how this same learning material (content) is comprehended by different subjects, that is, the individual meanings which students assign to a particular text, principle, idea and so on.

QUALITATIVE DIFFERENCES IN THE OUTCOME OF LEARNING

This paper is intended to provide an outline of the experimental procedure adopted in a series of studies reported in more detail elsewhere (Marton, 1975a, 1975b; Säljö, 1975; Dahlgren, 1975). In essence, groups of students were asked to act as paid volunteers. Each student, individually, was asked to read one or more passages of prose within suggested time limits, and was subsequently asked specific questions about the passage and, in some experiments, was also asked to explain to the experimenter what the passage was about. The conversation, which was recorded, allowed the experimenter subsequently to study the whole pattern of the response, including hesitations and various attempts at recalling different aspects of the passage which had been read. The student was then given a series of open questions to elicit how he had tackled the process of reading, and asked to answer a series of specific questions designed to assess what had been understood.

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* This article is based on a paper delivered at the 1975 Annual Meeting of the American Educational Research Association.

In one of our experiments we asked 40 female first-termers to read three incomplete chapters from Coombs: *The World Educational Crisis: A Systems Analysis* (1971, Swedish edition). The basic aim of the third of these chapters is to give the reader a thorough understanding of the effects of education on individuals and society—the output of educational systems. The point which the author wants to make in this connection can be seen from the following quotation:

> " It is impossible to measure with any presently known gauge the full output and eventual impact of an educational system. Some sense of what is involved can be grasped if we imagine a school whose whole output consists of a single student. On the day he graduates, what kind of an output does he embody? The answer is that he embodies a multiplicity of outputs—represented, for instance, in the facts and concepts he has learned, the style of thinking he has acquired, and also such changes as may have occurred in his outlook, values, ambitions, and personal conduct. If one then asks how all this will affect the future life of this student, his family and society, the difficulty is several times compounded. Such cause and effect relationships are often as indistinct as a line drawn through water. But if these matters are hard to get at in the case of a single student, they are infinitely more elusive when the matter to be judged is the output represented by multiple streams of individuals, flowing through different educational channels for different lengths of time " (Coombs, 1968, p. 64).

In subsequent pages Coombs argues against the simplified notion of output of educational systems as being equal to the number of people who pass their exams. He stresses the need for a large number of criteria in assessing the real influence of education on society.

In order to check whether the students had understood what the author wanted to say with regard to the output of educational systems the following question was posed:

" What is meant by the output of an educational system? " The words used in the answers to this question varied very much, but eventually we saw that students had adopted four basically rather different ways of comprehending what is meant by the output of an educational system. We shall call these four different types of answer *levels of outcome* which are thus concrete examples of qualitative differences in learning. The following classification presents what was understood at each of these levels together with two typical answers to illustrate the explanations given by the students.

Level A: The Effects of Education on Society and on Individuals Produced by Knowledge and Attitudes Acquired through Schooling.

> " Mm, that's terribly difficult to answer. There was this example about how if you just had one pupil and wanted to work out the output, it would depend on so many things . . . or factors or whatever facts or concepts it was about . . . whether he has completed his education, what his own viewpoint is . . . and everything that is going to influence his life later on and that sort of thing . . . and his productivity, suitability . . . "

> "Mm, it's the knowledge that . . . and values . . . yes, the knowledge and values that students have acquired. That is, whatever it is that influences them and makes them read this or that and do this or that."

Level B: Those Who Leave the Educational System With or Without A Qualification.

> " Well, those who have been to school and gone right through the course, and even those who've failed, they're a sort of output, too."

> " Well, it's those who pass their final exams, that is, well not necessarily pass, but those who take part in the course even if they drop out at some point, you know . . . those who have taken part and then dropped out."

Level C: Those Who Leave the Educational System with a Completed Education.

" It's the pupils who have gone right through the system from start to finish."

> " It's the trained work-force that the educational system produces. It's, well, for example . . . well, simply the trained work-force."

Level D: What Comes Out of the Educational System.

> " Something to do with . . . well . . . you know, the result of."
> " The product . . . I think."

The levels of outcome, i.e., different ways of comprehending what the author meant by ' output of education ' can be said to constitute the *outcome space* for this particular question in relation to the present text. Those answers which were categorised (by two independent judges) as belonging to level A are clearly the best since they contain the *intentional content* of the author's argument with evidence which shows that the subjects have grasped the more elaborate way of looking at ' output ' that the author wishes to convey to the reader. The B level answers contain a part of the intentional content since they include in ' output ' not only those who pass, but also those who drop out somewhere during their education, and the author considers this to be a very important aspect of the output of educational system. On level C we find answers which merely include those who pass through the complete educational system. This is the most common conception of output and is, in fact, precisely the conception which the author wants to argue against, since the real and important aspects of output are of a quite different nature from the mere number of people who pass. In fact, those students who gave a C level answer have given an explanation of output which is the exact opposite of the one the author intends to give the reader. The D level answers, finally, are virtually empty of content and in most cases they merely contain a translation of the term ' output.' The fact that this chapter was an attempt to give the reader a more sophisticated understanding of the concept of ' output ' thus seems to have completely escaped these students.

In the experiment from which this example is taken the question was given to the subjects on two occasions, as part of the content of an immediate retention-test given in conjunction with the reading session, and as a part of a delayed retention-test approximately 6½ weeks later. It is interesting to note that exactly the same levels of outcome can be found on the second occasion although in some cases individual students give answers at a different level from the first occasion. When looking at the results obtained on the measurements as illustrated in Table 1, one should bear in mind that subjects who did not give a Level A answer on the first occasion were given this type of explanation by the experimenter. As can be seen from the table, there is a remarkable stability in the answers given on the two occasions from the qualitative point of view—a point which is discussed more fully elsewhere (Marton and Säljö, 1976; Säljö, 1975).

TABLE 1

" WHAT IS MEANT BY THE OUTPUT OF AN EDUCATIONAL SYSTEM ? "
RELATIONSHIP BETWEEN LEVEL OF OUTCOME ON FIRST AND SECOND OCCASIONS 6½ WEEKS APART

Level		Second Occasion					Sub-Total
		A	B	C	D	O	
First Occasion	A	3		5			8
	B			4			4
	C	2		15	2	2	21
	D				2		2
	O*	1				3	4
Sub-Totals		6	0	24	4	5	39†

* O indicating no answer.
† One subject did not take part on the second occasion.

This example was given in order to illustrate the existence of qualitative differences in the outcome of learning. Different students obviously learn different things from one and the same text and their knowledge about various scientific principles, methods and ideas varies as regards *what is learned* instead of merely differing as regards *how much is learned.*

QUALITATIVE DIFFERENCES IN THE PROCESS OF LEARNING

If there are qualitative differences in the outcome of learning it seems very likely that there are corresponding differences in the *process* of learning, i.e., in the way different people set about learning. In fact, thinking in terms of qualitative variations has traditionally been more common as regards the process of learning than as regards its outcome. The best known examples are the works of Wertheimer (1945), and his student Katona (1940) who contrasted two methods of instruction in which the subjects either were taught the principle underlying the solution of a problem or were taught the actual solution of the problem. In accordance with commonsense psychology, subjects exposed to the former treatment retained what was learned longer and could with greater ease apply what they had learned to other problems similar to the training task.

In our studies of university students we have found marked inter-individual differences in the types of learning process that students engage in when confronted with learning materials. In fact, we have found basically two different *levels of processing* to be clearly distinguishable. These two different levels of processing, which we shall call *deep-level* and *surface-level processing*, correspond to the different aspects of the learning material on which the learner focuses. In the case of *surface-level processing* the student directs his attention towards learning the text itself (*the sign*), i.e., he has a 'reproductive' conception of learning which means that he is more or less forced to keep to a rote-learning strategy. In the case of *deep-level processing*, on the other hand, the student is directed towards the intentional content of the learning material (*what is signified*), i.e., he is directed towards comprehending what the author wants to say about, for instance, a certain scientific problem or principle. The following example illustrates these two different types of processing and the qualitative variations in outcome of learning which may follow.

RELATIONSHIP BETWEEN PROCESS AND OUTCOME

In another of our experiments 30 university students of educational psychology were instructed to read a newspaper article dealing with a curriculum reform in the Swedish universities. The analysis of qualitative differences in outcome of learning was in this experiment based on the subject's free recall of the article as well as on the answer to a summary question which read: " Try to summarise the article in one or two sentences. What is the author trying to say, in other words? " In order to be able to study long-term effects of the level of processing on retention, students were once again contacted and asked to recall the article and answer the summary-question after approximately five weeks.

Again, qualitative differences in outcome can only be described in terms of the content of the learning material. The newspaper article was 1,400 words long and included three tables. The article was mainly a critique of the approaching curriculum reform in the Swedish universities (UKAS), which aimed at bringing studies more into line with those at the polytechnic institutes through the introduction of set combinations of subjects and stricter regulations as regards duration of studies (termination in the case of unsatisfactory examinations results). The reason for the reform, as explained by the authorities, was that the examination pass rate at the universities was considerably lower than that achieved at the polytechnic institutes. The author of the article had, after examining the underlying statistics, divided university students into subcategories and was thereby able to show that, even though the pass rate was very low for certain categories of students, for other categories it was as high as, if not higher than, that achieved by technical students. The author argued that the blanket approach of the university reform, which would affect all equally, was misguided. If the pass rate was to be raised (and this was not considered self-evident by the author) selective measures should be taken by concentrating on those groups that did have a low pass rate.

Again it was possible to identify four different conceptions of the intentional content of the passage in the students' recall of the text and in their answers to the summary question. There was, of course, considerable variation in the words used by subjects to recall and summarise the article, but the variation in basic conception of what the author wished to say seemed to fall into the following four categories or *levels of outcome.*

Level A: *Selective Measures.* (Meaning that measures were to be taken only for those groups of students that did not fulfil the necessary requirements.)

Level B: *Differential Measures.* (Measures to be taken which allow for differences between the various groups.)

Level C: *Measures.* (Measures to be taken only.)

Level D: *Differences.* (Differences between groups only.)

These categories are hierarchically related (level A implies level B, which implies both levels C and D), as far as the amount of information on the intentional content of the article is concerned. The same categories could also be used in describing the retention of the intentional content at re-test, five weeks after the reading of the text. As Table 2 shows, except for one student, changes (if any) go from more to less deep levels of outcome (i.e., A→B→C). Since depth, in both our examples, is defined in terms of an implicational model, this transition indicates a loss of information.

TABLE 2

Article on Reform of the Swedish Universities. Relationship Between Level of Outcome on First and Second Occasion.

		Second Occasion				Sub-Totals
Level		A	B	C	D	
First Occasion	A	3	2			5
	B		4	6	1	11
	C			4	4	8
	D			1	5	6
Sub-Total..........		3	6	11	10	30

The next step in this study was to analyse the introspective questions, so as to ascertain functional differences in the *level of processing* which might explain the differences in the outcome of learning. Two different levels of processing were again clearly detectable from the subjects' comments on how they set about learning. In *surface-level processing* the subject focuses on *the sign* (i.e., the discourse itself or the recall of it). The following comments by students who had this conception of learning show how they described their approach to learning and remembering.

> " Well, I just concentrated on trying to remember as much as possible."
>
> " I remembered . . . but, I'd sort of memorised everything I'd read . . . no, not everything, but more or less."
>
> "It would have been more interesting if I'd known that I wasn't going to be tested on it afterwards,'cos in that case I'd've more, you know, thought about what it said instead of all the time trying to think now I must remember this and now I must remember that."
>
> " There were a lot of different lines of thought to follow and to try and memorise."

Deep-level processing indicated that students had concentrated on *what is signified* (i.e., what the discourse is about). Again students' comments illustrate their approach to learning.

> " . . . I tried to look for . . . you know, the principal ideas . . . "
>
> " . . . and what you think about then, well it's you know, what was the point of the article, you know."
>
> *Interviewer*: But when you were going to start, you tried to think: what came at the beginning of the article?
>
> *Subject*: No, I . . . I tried to think what it was all about . . . "
>
> " . . . I thought about how he had built up the whole thing."

Two judges rated students' comments independently in terms of the two levels of processing, although in some cases it was impossible to decide from the interviews what type of processing subjects had used.

Table 3 shows the relationship between what subjects said about their learning process and the level of outcome reached. There is a very interesting relationship between subjects' introspective reports and the qualitative nature of the outcome of learning. In some other studies we have been able to show that the level of processing which subjects engage in can be experimentally manipulated and that such manipulations may have very profound effects on both qualitative and quantitative aspects of the outcome of learning (Marton, 1974; Dahlgren, 1975; Säljö, 1975, ; Marton and Säljö, 1976).

TABLE 3

RELATIONSHIP BETWEEN LEVEL OF PROCESSING AND LEVEL OF OUTCOME.

Level of Outcome	Level of Processing			Sub-Totals
	Surface-level	Not clear	Deep-level*	
A			5	5
B	1	6	4	11
C	8			8
D	5	1		6
Sub-Totals ..	14	7	9	30

* Including one subject showing indications of both.

CONCLUSION

Our studies have been concerned with meaningful learning in the true sense of this term. The primary aim was to explore qualitative differences in what is learned and to describe the functional differences in the process of learning which give rise to the qualitative differences in outcome. Thus, what we wanted to achieve was a *commensurable* description of the process and outcome of learning in the sense that the qualitative variation which we discovered in the outcome of learning should have its counterpart in the process of learning, and *vice-versa.*

The most important conclusion we draw from our research is that learning should be described in terms of its content. A highly significant aspect of learning is, in our opinion, the variation in what is learned, i.e., the diversity of ways in which the same phenomenon, concept or principle is apprehended by different students. By gaining knowledge about how students comprehend, for instance, various scientific principles and ideas, we should obtain information which would undoubtedly prove fruitful for teaching. Consequently, we believe, it worthwhile to describe *the outcome space* of essential concepts and principles. The various *levels of outcome* will probably reveal the distinctive features and prerequisites of comprehension in these specific instances. We think, that, apart from what it may tell us about the general properties of cognition, it is of interest in its own right to describe what it takes, from a psychological point of view, to understand, for instance, the concept of scarcity in economics, or the law of diminishing returns (cf. Marton and Dahlgren, 1975).

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CONVERSATIONAL TECHNIQUES IN THE STUDY AND PRACTICE OF EDUCATION

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SUMMARY. Conversational theory is an attempt to investigate the learning of realistically complex subject matter under controlled conditions. To do this it is necessary to insist on restricted definitions of common terms such as understanding and to demand more stringent conditions before accepting that it has been demonstrated. These conditions can be achieved if the subject matter is structured and the student follows certain rules in demonstrating understanding. Computer linked systems have been developed which control and record student learning. The systems provide the experimenter with detailed records of the learning strategies used by students and the student with learning experiences which normally ensure understanding.

INTRODUCTION

THE intention of this paper is to introduce some of the basic ideas and techniques used in a series of recent investigations of learning involving realistically complex learning materials. It has proved impossible to give a full description here, and this may lead to misunderstandings about both the theory and the methods used. However, the ideas have been developed more fully elsewhere (Pask, 1975a, 1975b) and further details may be obtained from the author.

The starting point is the idea that the fundamental unit for investigating complex human learning is a conversation involving communication (see McCulloch, 1965) between two participants in the learning process, who commonly occupy the roles of learner and teacher. In an experimental situation, such as that used, for example, by Piaget, one of the participants is the experimenter who plays a less active role than that of teacher. Evidence of learning may come from comments or answers from the learner, or from the use of materials which demonstrates understanding more unambiguously than do verbal responses. In the research reported here the mental processes used by the learner in reaching an understanding of a topic are exteriorised by providing apparatus which controls his learning and also allows records to be made of the steps taken.

An essential part of the apparatus is a subject matter representation—a diagram of the relationship between concepts which need to be grasped before the topic as a whole can be fully understood. The student is provided with materials and practical demonstrations to help him understand the concepts and relationships and is allowed to explore the concept structure with a good deal of freedom, provided certain fundamental principles are not violated. The student progresses through his learning sequence generally by making a series of electrical contacts which show, by means of lights, what are his immediate learning tasks. The electrical contacts are also linked to a computer which monitors and records the steps taken. The computer thus provides a permanent record of the learning strategies adopted by the student and also prevents the student from making forbidden moves or attempting to go further than his present level of understanding allows. This procedure provides an effective learning environment for the student and also data for the research worker which allows him to examine learning strategies which are normally only accessible through introspection (as in the work described by Marton and Säljö in the previous paper).

These experimental methods represent an entirely different research procedure from those commonly used in investigating human learning. Conventional laboratory investigations (such as those by Wason, 1968) and factor-analytic studies (Guilford, 1960) provide important evidence about certain types of intellectual activity or structure, but it is argued that conversational theory, as developed later in this paper, provides important evidence about how students learn realistic bodies of subject matter over appreciable intervals.

In fact, the theory takes us much further than that. It permits the investigation of other important, but elusive, aspects of human learning which have educational implications—notably, the nature and control of understanding; the nature and use of analogical concepts; learning style; innovation; and learning to learn. The chief drawback is that it becomes necessary, in developing conversational theory, to redefine common terms (such as understanding) to have a restricted and more precise meaning and also to introduce new terms in describing the operation of the apparatus used in these studies. These various terms are italicised when they are introduced and the sense in which they are being used is explained. Another problem in describing this approach to learning is that it no longer is possible to make a clear distinction between learner and teacher in describing the two participants in the conversation which leads to learning. It soon becomes clear that the brain of the person who is learning can operate in two distinct modes which can be viewed as ‘ teacher ’ (directing attention to what needs to be done) and ‘ learner ’ (assimilating the subject matter), when a student is using structured learning materials and appropriate heuristics.

It is, of course, risky to set up a new theoretical structure. Most traditional theories are well founded in experimental work and have demonstrated their value in some applied fields. However, the current approach rarely, if ever, contradicts well established ideas on learning; rather it reinterprets them in a way which has greater educational utility and which also unifies ideas and evidence derived from other experimental procedures. Conversational theory basically sets up a **system** within which to view learning. In this it resembles the information processing approach to perception and learning described by Broadbent (1957, 1971), Miller *et al.* (1960) and Welford (1968). The methods adopted however, draw from a wide variety of approaches. It makes use of, for example, the experimental procedures and ideas of Piaget (e.g., Flavell, 1963; Vygotsky, 1962; and Luria, 1961); personal construct theory (Kelly, 1955); transactionalism (Laing *et al.*, 1966 ; Bateson, 1972) ; behaviourism ; and eclectic functionalism (Bartlett, 1932; Poulton, 1953). Moreover, conversation theory accommodates the structural psychology of Scandura (1973) and, as a bonus, can draw on ideas from the fields of artificial intelligence and computer-aided instruction.

Previous research using conversational techniques.

The techniques of observation and recording of conversations in the study of learning are not, in themselves, new. The themes pervading conversation theory have been voiced repeatedly. There are also methodological precedents in the approaches of Piaget of Vygotsky, or Papert (1970) which represent conversational methods for probing, observing and exteriorising normally hidden cognitive events—notably, the ‘ paired experiment ’ and the ‘ questioning interview.’ Both techniques rely upon a participant experimenter in the role of a tutor, interviewer or interrogator, who shares in the mental activity of the respondent but who still obeys certain pre-specified, though conditional, rules.

Several aspects of these methods are of special interest: the eliciting of explanatory responses, the notion of agreement between participants, and the representation of thoughts and discoveries. The problem situation is embodied in a physical artefact, such as a puzzle, a mechanical gadget, or else a concrete situation (water jars, metric rods and other means of depicting conservation of quantity, volume, etc.). Whatever the apparatus may be, it is jointly perceived by the participants (respondent and experimenter) and is open to external observation.

The experimenter poses problems (some of them designed to place insuperable obstacles in the respondent's path) concerned with the function of the artefact or extensions of its function. The respondent replies, either verbally or by manipulating the artefact. Typically, the questions involve 'How' and 'Why' and the answers, if forthcoming, are explanations or constructive responses. Since some enquiries are designed to pose insoluble problems, the respondent sometimes appeals for help and, in this case, the experimenter performs a demonstration or points out a principle or suggests some way in which the artefact could be modified. All explanations, whether verbally uttered or not, can be interpreted in relation to the problem situation. Thus, the participants are able to reach an agreement and the basis for their agreement is exteriorised for impartial scrutiny. Parallels with conversational theory will subsequently become apparent.

THE DEVELOPMENT OF CONVERSATIONAL THEORY

Conversational theory, as already stated, represents a systems approach to learning. It has certain basic postulates and definitions through which its properties are described. Learning is seen as taking place through **interpreted formal relationships**, such as 'next,' 'adjacent,' 'periodic,' 'dual,' 'sum,' or 'product.' These formal relationships are interpreted in terms of a context (societal, electrical, mechanical, statistical) and appear as sets of connected propositions (physical laws, social theories) which will be called **topics**. The **specific** meaning of this, and subsequent terms, must be noted. The **concept** of a topic is seen as a way of satisfying the relationships embodied in that topic, rather than simply a stored description. Similarly, a **memory** of a topic becomes a procedure which reconstructs or reproduces concepts. Within conversation theory learning develops through **agreements** between the participants which subsequently lead to **understanding** by the learner. Again the terms have a specific meaning which depends on the apparatus used for controlling learning and demonstrating understanding.

In normal conversation understanding of a topic is demonstrated if the learner provides a verbal explanation of its meaning in accord with an accepted standard definition. In the typical Piagetian experiment understanding is demonstrated by both verbal and non-verbal means. The experimenter questions the child, but also observes manipulations of the apparatus, and ultimately agrees that a valid explanation is given. In our own work, extensive use is made of modelling facilities in which the student's model building behaviour provides non-verbal explanations of a topic and thus exteriorise some of his thought processes. While agreement can be reached at a verbal level between student and teacher and is a necessary condition for understanding, within conversational theory additional evidence of understanding is required. Not only must the student be able to describe the concept (which may reflect only rote or temporary learning), he must also be able to use the underlying relationships by operating on appropriate apparatus to demonstrate understanding.

A concept of, say *T*, has been defined as an internal procedure which brings about and satisfies *T*. The procedure is a class of what may be thought of as 'mental programs' which satisfy the relationships embodied in *T* and there will be many ways, using a modelling facility, in which *T* can be represented. 'Teacher' and 'student' may choose different ways of representing *T* in practical terms, but the concepts will be equivalent if both representations, when executed, lead to the same outcome, or satisfy the same relation. **Agreement** will then have been reached about the concept, but understanding may still not have been satisfactorily demonstrated.

Within conversational theory **understanding** depends on the ability to reconstruct the concept of *T*. The only demonstrably stable or permanent concepts in the memory are seen as those which can be reconstructed *ab initio* by applying certain common cognitive operations to topics which are initially understood. For the present it is convenient to group a variety of cognitive operations under a single term '**discovery**' (Belbin, 1969). This 'shorthand notation' carries with it a recognition that the underlying mental operations are psychologically and formally distinct, and that students will differ in their competence to use different kinds of 'discovery' operations.

To ensure that a demonstration of understanding is unambiguous it is required to be carried out in a particular way, using modelling facilities in conjunction with a subject matter representation which summarises the relationship between topics within the subject matter. This leads to the next crucial part of conversation theory—that the student should see in advance the 'map of knowledge' through which he is to work.

Subject Matter Representation.

In the Piagetian interview or the paired experiment, the participant experimenter probes the respondent in order to draw out his concepts of the problem situation—for example, by asking why or how an event takes place, or what would happen if some feature of the situation changed. In this type of learning the experimenter must have a comprehensive knowledge of the learning **domain** to provide appropriate corrective assistance. The experimenter can thus be assumed to have a mental 'map' of the subject matter, against which to compare respondent's responses. Such an internal representation of knowledge has the defect that only the verbalised parts brought out through the conversation are made accessible to the respondent, or to an external observer. It seems clear that there must be great advantages in providing **both** participants with an external representation of the subject matter through which topics can be identified and discussed. In this way, explanation can be initiated by either participant.

Allying this idea to the earlier formal definitions of concepts and topics, it becomes necessary to develop a network of topics and concepts which represent the chosen subject matter area. It is also necessary to ensure that the formal relationships between the concepts are made explicit within the network. The final network within which the student works is called an **entailment structure,** which is developed initially from discussions with a subject matter specialist and later through working out more precisely the logical relationships involved.

The starting point is a thesis on the chosen subject area expounded usually by a subject matter expert, although it can be done by a student. The thesis is then broken down into a series of derivations bringing out the various topics, concepts and relationships involved. Each topic relation stands for a class of valid explanations of the topic, or it can be thought of as a series of abstract programs which would satisfy the topic relation if they were compiled and executed. Again, to meet the requirements of the narrow meaning of **understanding,** the entailment structure developed must have the type of ' cyclicity ' which allows a student to reconstruct a concept and also have ' consistency,' implying that all the topics can be separately identified and connected by derivation paths.

Development of an entailment structure.

The techniques which have been developed for enabling subject matter specialists to expound a thesis within the constraints imposed by conversation theory involve interaction with a computer which stores the information already provided and also provokes the expositor(s) to further clarification of the underlying relationships. It is important to stress that the resulting structure, describing say ' optics,' is merely the expositor's thesis on optics. It is not ' optics ' in any ideal sense; the thesis represents only the personal construction of one or more expositors.

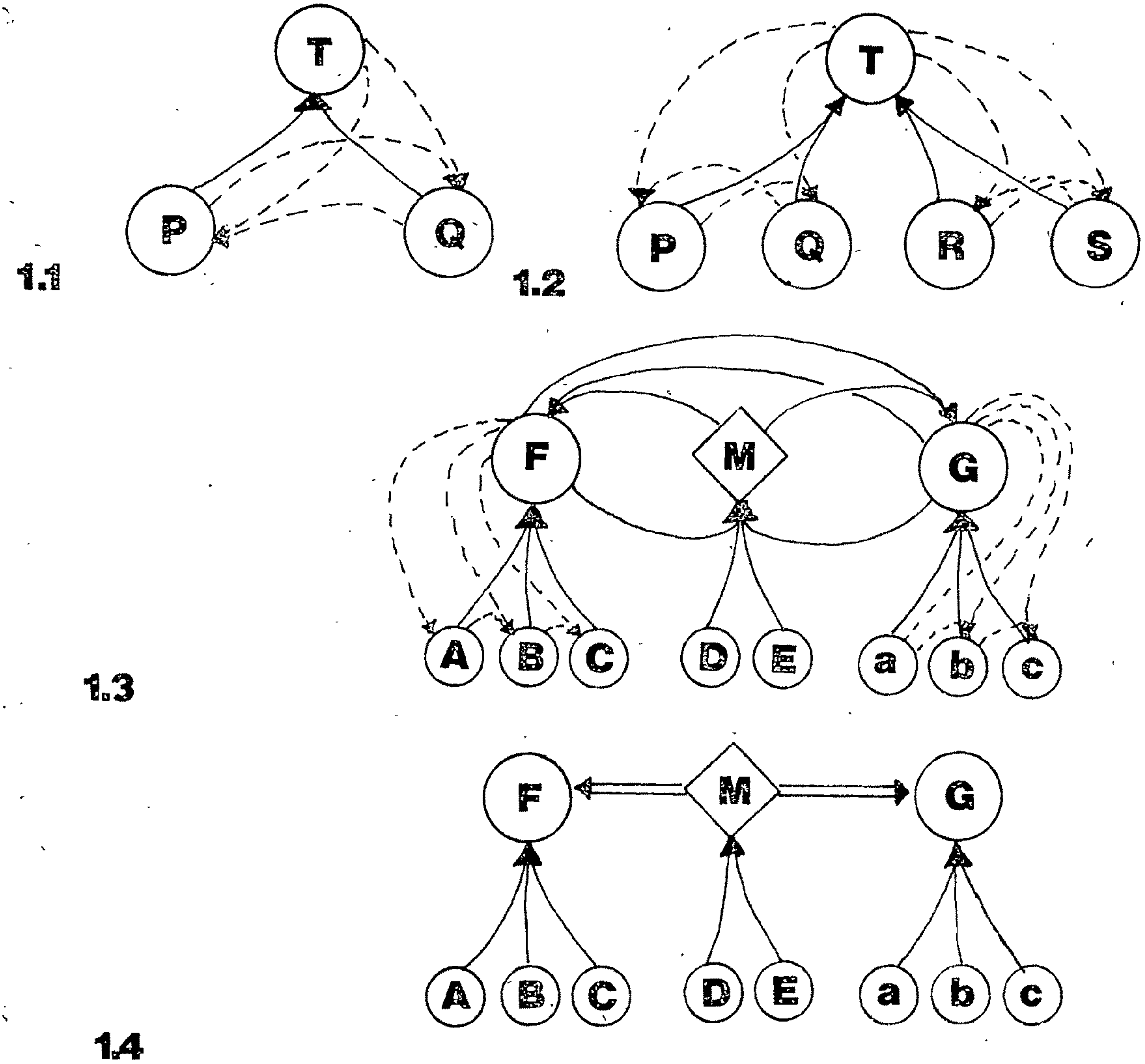
Initially the subject matter specialist is required to cite topics which are involved in his thesis—say *P*, *Q*, *R*, *S* and *T*. Next he is asked to construct a thesis on the assumption, which is later checked, that he can explain each topic by saying how it is derived from the others. Suppose his thesis is that *T* is derivable from *P* and *Q*. In terms of conversation theory, this means that an explanation of *T* can be derived from an explanation of *P* and *Q*, provided that the student is capable of the cognitive operations which have been labelled **discovery**. The expositor's derivation is accepted if, and only if, an explanation of *P* and *Q* can also be derived from the explanation of *T*. This requirement provides the necessary cyclicity or ' getting back ' property which can later be used to demonstrate understanding.

There may be, and nearly always are, different ways of deriving *T*—from *P* and *Q*, say, but also perhaps from *Q*, *R* and *S*. Such derivation paths are kept distinct and are conveniently exhibited to the expositor in the form of a diagram, or directed graph, in which the **nodes** stand for topics, the **arcs** for parts of a derivation and the **arc clusters** (e.g., the pair of arcs linking *P* to *T* and *Q* to *T*) for derivation paths. Figure 1.1. shows the structure '*T* derived from *P*, *Q*,' while Figure 1.2 shows '*T* derived from *P* and *Q* or from *R* and *S*.'

The term **entailment** is used as shorthand for the whole relation represented by " derivable from . . . given the necessary cognitive operations involved in discovery." To codify entailment it is necessary at least to discriminate between axiomatic, purely formal, derivations and **correspondences** (morphisms, such as isomorphism) which depend upon the potential, but not yet identified, universes of interpretation. For example, no such distinction is shown in Figures 1.1 or 1.2, but one does appear in Figure 1.3 (which is explained in simplified form in Figure 1.4 and its footnotes) where electrical and mechanical universes of interpretation are identified.

As a thesis is expounded under the constraints demanded to maintain cyclicity and consistency, its representation burgeons into an expanded version showing a whole series of topics (nodes) and inter-connecting lines (arcs). At this stage the diagram is called an **entailment mesh,** which must later be simplified and tightened up to form the final entailment structure. As the mesh develops the expositor is urged to expand the thesis by saying what the peripheral topic relations are, and these additions cause the mesh to widen and produce more interconnections between topics.

FIGURE 1



DERIVATIONS.

1.1. topic T derived from topic P and topic Q.
1.2. topic T derived from topic P and topic Q, or from topic R and topic S.
1.3. a correspondence, M, between topics F and G, depending upon D and E (see explanation below).
1.4. a shorthand notation for Figure 1.3. when interpreted (see text) to represent an analogy.

One plausible interpretation of Figs. 1.3 and 1.4 is as follows :

F=Mechanical Oscillator.
G=Electrical Oscillator.
A=Mass.
B=Friction.
C=Elasticity.
a=Inductance.
b=Resistance.
c=Capacitance.
D=Properties (predicate name) distinguishing electrical and mechanical universes.
E=laws of simple harmonic motion.
M=Analogical Topic containing the formal similarity (E) which is common to F and G as well as the class of property—value distinctions (D is only one of any) which express differences essential to any analogy relation.

At this stage the structure, as stored by the computer, contains nodes with names, but only a ' formal ' or abstract meaning. Subsequently the expositor provides adjectives or **descriptors** which give ordinary meaning to the topics within the entailment mesh. But, once this is done, we move away from the abstract graph, towards the practical descriptions of the concepts later developed within the ancillary modelling facilities.

Most studies which employ explicit representation of subject matter take it for granted that a description is given and understood by the participants. Commonly, this description is just sensibly chosen, as in Bruner, Goodnow and Austin's (1956) study of concept acquisition. Sometimes it is based upon a factor analytic resolution of semantic scales, as in Osgood's (1962) semantic differential techniques. Among the exceptions to this rule is work by Thomas (1970) and his associates in which exploratory conversations, often concerned with learning, are based upon mutually generated descriptions. Such descriptions are obtained from one respondent (here an expositor) by applying the repertory grid sampling procedure technique (Bannister and Mair, 1968) to elicit descriptors and their values which are Kelly's (1955) ' personal constructs.' If the situation warrants serious attention to the description (construct) schemes of several expositors a more sophisticated routine, exchange grids (Thomas, 1970), is used to compare individual views and obtain a mutually shared description.

Within conversational theory we opt for descriptors that are personal constructs and which are also compatible with the formal structure already laid out. (This approach allows students to become expositors.) The description process can be shown briefly by the following stages:

(1) The expositor chooses a **head node** which is the topic he believes his thesis is about. Many head nodes may be produced in the formation of an entailment mesh, as expositors often recognise the ' true ' head node fairly late in the process.

(2) The mesh is now pruned (by removing the dotted ' back linkages ' in Figure 1) to yield a structure that is hierarchical apart from the introduction of correspondences (as in Fig. 1.4) which become analogy relations, once they are interpreted.

(3) The putative analogies are ordered and groups of them are used as though they were ' objects ' in repertory grid administration. Each group of nodes is used to generate at least one construct (or descriptor name) having real values (+, —; or rating scale numerals) that discriminate the topics which are related by the analogy and the value NULL (' * ' or ' irrelevant ') on the analogy itself. For example, in Figure 1.4 the descriptor name, ' Scientific Discipline ' may be entered as D and has values ' Electrical ' and ' Mechanical ' on topics F and G (electrical oscillator ' and ' mechanical oscillator ') D is the difference part of an analogy relation (node M). The systemic or formal similarity preserved by the analogy is expressed by the equations for simple harmonic oscillation (node E). All constructs so far elicited are given values on all the nodes (as in rating constructs over all the objects in a set, not just the triple selected for construct elicitation in Kelly's approach).

(4) The process continues until all topic nodes can be **uniquely** identified.

(5) At this stage the main descriptors divide up into independent universes of interpretation for each of which an independent part of the modelling facility is required. The lowermost nodes, which refer to a particular part of the modelling facility, specify the kinds of formal relations that are to be modelled in it when (non-verbally) explaining topics with nodes at a superordinate position in the hierarchy. For example, in Figure 1.4, two partitions of the modelling facility are required—one is a simple 'electricity bench,' while the other is a simple 'mechanics bench' both of which would be found in any school physics laboratory. In this case, it is necessary to model both electrical circuits and mechanical devices (with springs, weights, and so on), some of which act as simple harmonic oscillators.

(6) The entire pruned and described entailment mesh now created forms the **Entailment Structure.**

(7) Finally the expositor is required to do what was originally described as necessary, namely to use the modelling facility, which has now been specified, to express the class of valid explanations for each topic of the Entailment Structure in a standard form which can be represented unambiguously in a computer. Perhaps the most suitable name for such a standard form of explanation is a **behaviour graph (BG)** meaning the (many different) prescriptions for building models that act as non-verbal explanations; **not** to be confused with the behaviour produced if the model is executed (either externally, in the facility, or 'internally' in the student's brain). Elsewhere, the **BG** has been termed a **task structure.**

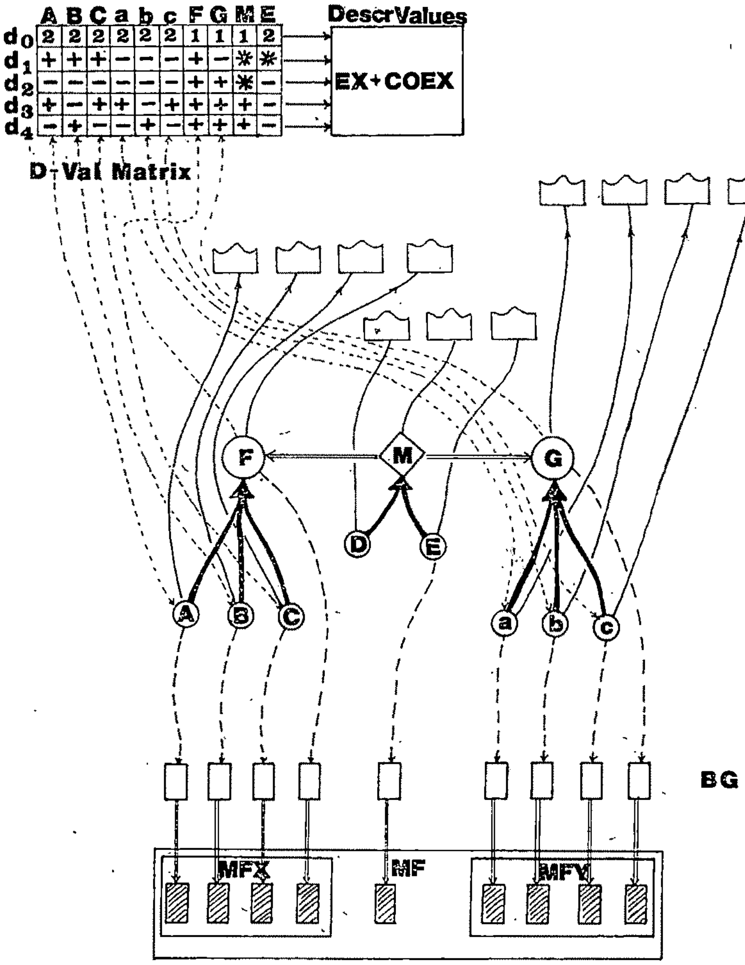
The Conversational Domain.

The result of the efforts of the expositors to fulfil the conditions imposed by conversational theory on the description of a thesis is a **conversational domain** (such as that shown in Figure 2), which represents in diagrammatic form the apparatus necessary to explore the relationships between such topics as the laws of simple harmonic motion and the behaviour of electrical and mechanical oscillators (as shown in Figures 1.3 and 1.4). This conversational domain consists of:

(*a*) an entailment structure;
(*b*) the associated collection of **BGs** indicating acceptable explanations;
(*c*) the modelling facility, partitioned into appropriate universes such as mechanical or electrical apparatus with which to test understanding of topics;
(*d*) descriptors which explain in everyday language the subject matter contained formally and symbolically in the entailment structure;
(*e*) various signalling and information storage arrangements that are attached to the topic nodes (lamps to guide the student, and pulses passed to the computer indicating the step being taken by the student); and
(*f*) examples and counter examples, usually displayed graphically, that provide the context for the descriptors and hence give meaning to the thesis.

The example given in Figure 2 is much simpler than entailment structures used in actual experiments. For example, a thesis on heat engines involved 60 nodes; reaction kinetics involved 180, meiosis and mitosis 275, probability theory 320, while the maximum used so far has been 500 nodes (statistics).

FIGURE 2



	A	B	C	a	b	c	F	G	M	E
d_0	2	2	2	2	2	2	1	1	1	2
d_1	+	+	+	–	–	–	+	–	*	*
d_2	–	–	–	–	–	–	+	+	*	–
d_3	+	–	+	+	–	+	+	+	+	–
d_4	–	+	–	–	+	–	+	+	+	–

Topic nodes **F, G, M, A, B, C, a, b, c,** and their connections are part of the entailment structure as it is displayed to the participants in a conversation. Each node is associated with computer storage and coloured lamps which act as state indicators showing transactions or states such as **Explore, Aim, Goal, Working, Understood.** Nodes are accessed by naming conjoint descriptor values and the system picks out a node through descriptor value matrix (assigning descriptor values to nodes). Here we use only the values +, –, * (irrelevant) and 1, 2; in general, descriptors are many valued. Each cell in the matrix is electrically connected via a random access projector to slides presenting example(s)/counterexample(s) (the array EX-COEX). Each node in entailment structure (apart from **D** which is a descriptor name) has an associated behaviour-graph **BG,** which determines models (shaded rectangles, below **BG** rectangles) in a modelling facility **MF.** Thus, the **BG** of **F, A, B, C** yield models in **MFX** (mechanical) and the **BG** of **G, a, b, c,** yield models in **MFY** (electrical). Topic **E** may be modelled in either part of the facility or as an abstract mathematical equation. Modelling the analogy relation, **M,** implies building a model in **MFX** and the properly corresponding model in **MFY** and relating the models, under execution, so that E-principles are common to both models.

Key to Notation:

□ = Behaviour Graphs BG nodes attached by ——> link.

▨ = Models (either demonstrations or non-verbal explanations) generated (⟹) from BG.

○, ◇ = Nodes in entailment structure.

⌂ = Storage and display arrangements (for **aim, goal, understand,** etc.) connected by —>— to each node.

<——> = Accessing connections from matrix to nodes and *vice versa.*

Descriptor names and values compatible with the interpretation of this entailment structure suggested in the caption of Fig 1.4.

d_0 = Level = distance from Head. Values 1 or 2.

d_1 = **Discipline.** Values, Mechanical (+), or Electrical (–) or irrelevant (*).

d_2 = **Dynamic Periodicity.** Values +, –, or irrelevant(*).

d_3 = **Storage and release of energy.** Values +, –, or *.

d_4 = **Waste or dissipation of energy.** Values +, –, or *.

TUTORIAL CONVERSATIONS AND TRANSACTIONS

The student using a conversational domain is able to undertake various learning activities or **transactions** either with an experimenter who responds verbally, or by relying on information provided in pamphlets under computer guidance within the framework of the entailment structure. In order to give a clear idea of what might take place in a conversational domain consider a tutorial conversation in which one participant (*B*) is the teacher, while the other (*A*) is the learner.

Participant *A* is ignorant of some of the topics and ultimately intends to learn the head topic. He has access to the modelling facility, the entailment structure, and its description scheme. *B*, in addition, is given access to and control, over the descriptive examples and counter-examples, the various *BG* and the state-markers which indicate the transaction taking place. *B* can take advantage of this polarity to act in the role of a teacher. *B* may use all kinds of acumen; he may learn about *A*, give good advice and so on. All we require is that the assistance he gives and the agreements he reaches are compatible with and derived from the entailment structure and its *BG*.

The following types of transaction may take place:

(*a*) *A* can ask *B* about the values of descriptors in general, and he can point out topics by citing topic descriptions, **i.e.,** combinations of descriptor values. For example, referring to Figure 2, *A* can access the node encoded as *G* by conjoint statements like '**Level** (d_0)=1 and **Discipline** (d_1)=Electrical' or by 'Periodic (d_2=+) and Discipline (d_1)=Electrical' or by any other combination that identifies this node. If he can uniquely point out a topic, he can ask what other descriptors (if any) have other than null values on these topics, and, if so, what the values are. These questions are efforts to make sense of the domain, and if *B* answers the questions by providing examples and counter examples of descriptor values to which he has access, they form part of what are called **explore transactions.**

(*b*) *A* can state his intention to come to grips with any topic that he can point out uniquely, using a combination of descriptor values. Such a statement is an intended immediate aim in learning. If *B* is wise he will check *A*'s sincerity (for *A* might point at topics haphazardly) by determing that *A* appreciates the meaning of the descriptors used to specify the intended aim. Assuming this precaution has been followed, we then refer to the original intention statement as an **aim request.**

(*c*) *B* validates the aim by asking *A* multiple choice questions spanning the values of these descriptors and *B*'s reply is evaluated by confidence estimates over the response alternatives, to questions about the descriptors. If *B*'s certainty about the correct alternatives is high enough to make learning feasible (appropriate indexes, θ^*, are described in Baker, 1969; Shuford *et al.*, 1966; and Dirkswager, 1975), then the topic node is instated as the current **aim**; failing that, *A* is requested to engage in further **explore** transactions to obtain further information and so to increase the value of θ^*.

(*d*) Once an aim is instated, its node is marked by a signal light visible to both *A* and *B*. Then *A* can ask *B* questions like "How am I permitted to learn about the aim topic?" and *B* is in a position to reply either by a gross display of all derivation paths or by delineating permissible derivations from the aim topic to topics which appear lower in the hierarchy and are marked **understood**, or else to topics which are lowest and simplest nodes.

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(*e*) Given this information, *A* is also able to indicate the topic or topics he immediately wishes to learn about. The topics *A* desires to learn about are called **goals**; and these are marked with a goal signal to this effect. There may be one goal or several; if there is only one goal it may, in fact, be the aim topic.

(*f*) If *B* is wise he will check *A*'s ability to learn about the selected goals by seeing that: (1) the goals are all situated on allowable paths; and (2) each permissible goal satisfies the condition that, for at least one derivation path leading to that goal (and usually there are many paths), all immediately subordinate topics in this path are marked as being understood. Any goal satisfying these criteria is called a **working topic** and the goal signal is changed to a working signal.

(*g*) If *A* disputes *B*'s evaluation of his understanding or if no topics are currently marked as understood (which is the starting condition) then *A* can engage in an ' explain and derive ' transaction. First, *A* must show that he can explain the outstanding topic (an *A*, *B* agreement over models for the topic). If so, then *A* must show that he can also explain the immediately subordinate topics on some allowable derivation path. Then the outstanding topic can be marked as understood.

(*h*) All the transactions leading up to the selection of working topics are components of a ' higher level ' agreement, namely, an agreement regarding the derivation of the topic.

(*i*) For any working topic *A* can, if he wishes, attempt a non-verbal explanation. On the other hand, he can request information by asking for example, " How do I explain this topic? " *B* is in a position to reply by recourse to the *BG* of the topic which generates the accepted non-verbal explanations of the topic. These model building behaviours are called **demonstrations** since they are delivered as though by a laboratory demonstrator. After each demonstration, *B* asks *A* the question " How do you explain this topic? " and *B* keeps a record of all the demonstrations so far delivered.

At some stage, either *A* constructs an explanatory model for the topic or else the topic is discarded. Explanation (model building) often involves trials and self-corrected revisions. When *A* is satisfied with his ' final version ' he submits the explanation (or explanatory model) to *B* who checks it to make sure it is not a replica, parrot-wise, of a demonstration already seen by *A*. It is accepted as understanding if this condition is satisfied and if there is 'agreement' in the sense explained earlier.

Generally, the explanations are non-verbal (models) and *B*'s model will be found, like a demonstration, among the *BG* of the topic in hand. Under these circumstances, agreement and correctness are both secured, if both models do, on execution, satisfy the same relation. If so, the topic is marked **understood**. If not, *A* may opt for more demonstrations or revise his approach (**aim** and/or **goal** selection).

The crucial point is that an understanding in the present strong and special sense is determined by a two level agreement: *A* and *B* agree about a derivation and, in the context of this derivation they also agree about an explanation of each topic.

Once a node is marked as understood, its state does not change during the rest of the conversation. The justification for this rule is our postulate (and experience) that understood topics have concepts that are stable.

(*j*) The transactions which lead up to the ' higher level ' agreement about a derivation are exteriorised, physically, as a series of node-state distributions displayed throughout the learning process, both to *A* and to *B*. These diagrams, showing the distributions of explore, aim, goal and understood markers represent learning strategies, which show how the student tackled his attempts to reach and understand his learning goals. Examination of the paths shown in these diagrams have led to the identification of characteristic learning strategies which will be described in a subsequent paper, together with systematic individual differences in competence to learn and discover.

COMPUTER CONTROLLED CONVERSATIONS

In the tutorial condition described so far, *B* provides the answers to *A*'s questions and gives appropriate demonstrations. His actions may involve help and encouragement, but the basic core of these activities depends only on the conditions imposed by conversation theory within the particular domain being explored. It is thus possible to replace the tutorial arrangement with what is called the **standard experimental condition** in which the tutor's control is handed over to a computer, or to an experimenter who has no teaching function.

Operating in this condition the student is required to accept certain rules. He must:

(*a*) intend to learn the head topic;
(*b*) obey the transaction rules (as described earlier);
(*c*) have only one aim at a time (except those which are being explored);
(*d*) not already understand the head topic; and
(*e*) undertake some transactions until the head topic is finally understood.

Under these conditions the computer is able to direct the student to appropriate information and demonstrations available in pamphlets and on tape/slide presentations. The student can carry out tests of his understanding and the computer will check which of the derivations are correct, in terms of the *BG*. The student thus progresses as he did with the tutor present and again it is important to realise that the variety of paths and demonstrations available means that students have considerable freedom to learn within the constraints of the system as a whole.

This standard condition shows why it was stressed originally that the distinction between teacher and student can no longer be maintained. In the tutorial arrangement *A* interacts with *B* through the conversational domain within the defined restrictions. But under the standard condition what happens? *A* does not converse with the machine, although the computer checks the moves made. In fact, *A* behaves in the two ways described earlier. One part of his brain (A_1) works out the moves to be made, asks questions, seeks answers, while another part (A_2) is trying to understand the topics.

Operating System Using Conversational Theory.

To date two pieces of equipment have been developed within which conversational domains can be established. CASTE (Pask and Scott, 1973) is a computer controlled laboratory installation. A portable version, INTUITION, has been used for research in schools and colleges and is relatively inexpensive. Both systems contain a board showing a diagram of the entailment structure with electric sockets at the nodes surrounded by coloured lamps which indicate the transactions being undertaken and the stage the student has reached in learning the topics. The student uses wires to connect sockets according to the rules laid down, and the computer checks that each move is acceptable. The modelling facilities and ancillary descriptive materials are also part of the equipment. Figure 3 shows INTUITION as it has been used in schools for a thesis on probability theory.

A variant of these systems which does involve a tutor has also been used. This has been given the name TEACHBACK. In this system the tutor (*B*) attempts to maintain a neutral role by acting the role of a student and asking the learner (*A*) to provide an explanation of his own for each topic selected. He must also explain how he derived that explanation. TEACHBACK is important because it provides additional information about how students learn from (stilted) verbal transactions, as well as providing the standard behavioural information. The method has been used successfully in conjunction with tests, but only over short learning periods. The neutral role is hard for the tutor to maintain, particularly in large subject-matter domains. One-and-a-half hours has proved the maximum period for TEACHBACK to operate at a time.

CONCLUSION

Conversational theory is built up from stringent definitions of commonly used terms such as understanding and memory. It is associated with a system of learning in which the subject matter is broken down into its basic elements and reconstructed into an arrangement of topics which provides a ' map ' for the student. Rules cover the transactions made within the system, but the student is able to follow different paths and obtain various demonstrations before testing his own understanding of topics. He is also free to adopt his own learning strategy within defined limits.

It is possible to view other experiments on learning as approximating to the conditions described here. For example, in TEACHBACK the student is involved in free learning, exploratory behaviour, and is guided by a neutral onlooker. The experiments of Luria and Piaget follow a similar approach, but lack the demands for proof of understanding built into the standard condition of conversational theory. Of course, the test of the theory will be in its explanatory power, on the one hand, and in its effectiveness in bringing about understanding on the other. Some indication of explanatory power has already been given and a subsequent paper will provide evidence of the effectiveness of the systems so far developed, in which students learn, understand and remember complex subject matters.

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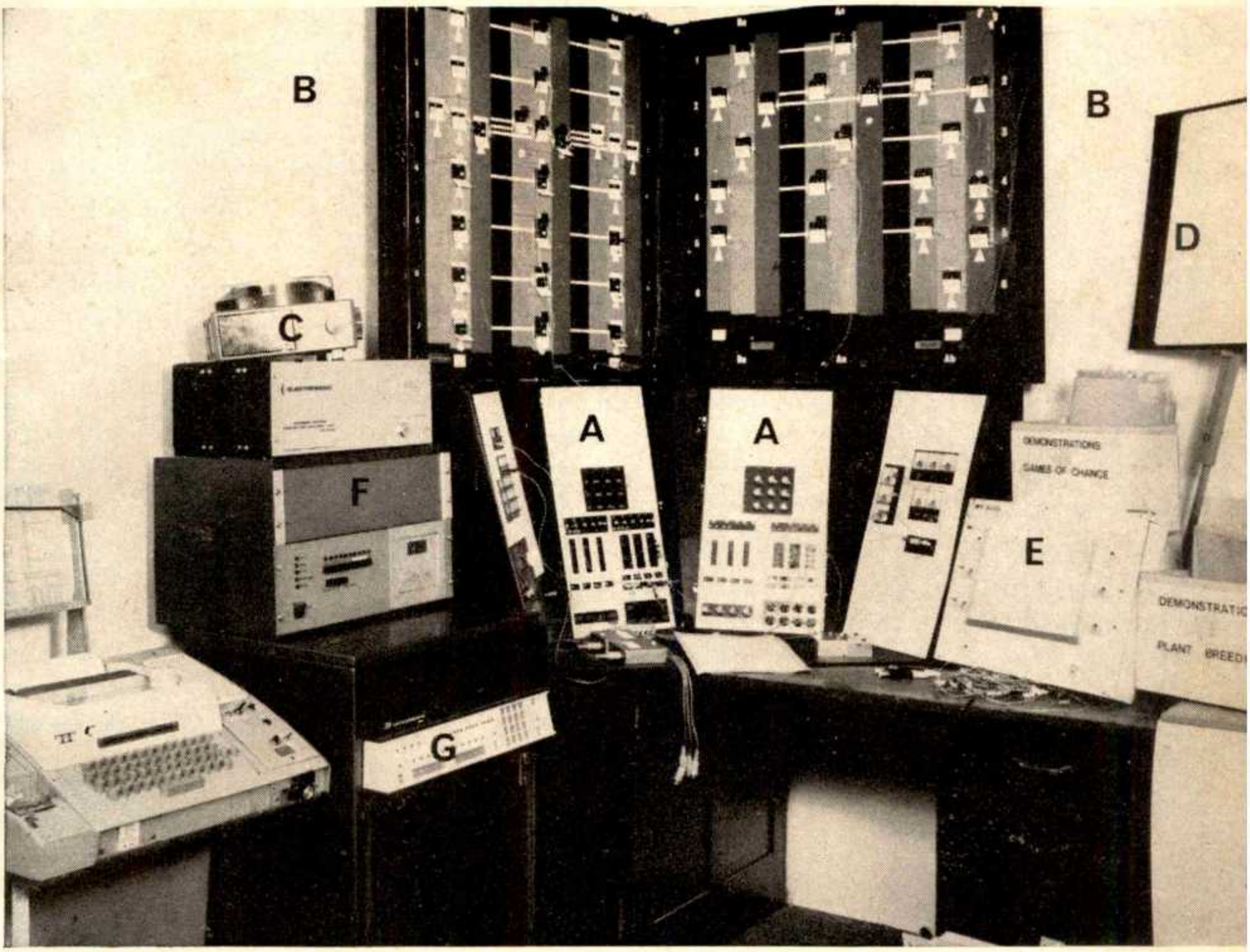
FIGURE 3



The 'INTUITION' Conversational system as used for learning about 'probability theory.'

A = Modelling Facility for topics in Probability theory: a 'Probability laboratory' in which demonstrations are given by instruction cards laid over fascia and in which non-verbal explanations are elicited.
B = Entailment Structure. Each topic has node with group of 'state' signals. Entailment connections shown by lines and descriptor values by colour and alpha-numeric coded regions.
C = Random Access Projector, Displaying examples and counter examples as required in explore transactions.
D = Screen.
E = Confidence Estimation console and questioning device.
F = Controller and recorder.
G = Minicomputer (can service several student stations).

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RETROACTIVE INTERFERENCE IN MEANINGFUL LEARNING

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Summary. It has been suggested that the phenomenon of retroactive interference, by which retention of verbal materials is decreased by the subsequent presentation of similar interpolated items, occurs only in unstructured items, and not in the meaningful and connected information more commonly encountered in educational learning circumstances. An experiment was undertaken to investigate the possibility of retroactive interference occurring in a structured and meaningful prose learning situation. The sample consisted of 18 university students allocated randomly to two groups. The experimental group studied an original prose passage, followed by two very similar interpolated passages. Their final cued recall scores were significantly lower than the scores of a control group, who learned the identical original prose passage, followed by the dissimilar passages.

INTRODUCTION

The phenomenon of retroactive interference, whereby performance at tasks requiring learning is decreased when materials similar to those being learned are interpolated between presentation of the original items and subsequent tests of learning and retention, has been observed in a variety of verbal tasks. According to McGeoch's (1942) early formulation, responses acquired during the original and interpolated learning situations and attached to similar stimuli remain available and compete with each other during the recall of the original material.

It has been asserted that retroactive interference may exert strong effects upon performance in learning situations encountered in school. Accordingly, teachers have been advised by psychologists to avoid presenting materials to be learned in ways which might produce substantial interference. For instance, Macdonald (1965), in a popular textbook on educational psychology, warns, "in general, the teacher should expect students to have difficulty retaining highly similar materials which are learned in close proximity to each other" (p. 239). Similar advice has been included in a number of other books on psychology addressed to classroom teachers (e.g., Andreas, 1968; Bigge and Hunt, 1968; Blair *et al.*, 1968; Edwards and Scannell, 1968; Mouly, 1968).

However, the findings of a number of experiments have cast doubts on the claim that retroactive interference is a major influence in the relatively structured and highly meaningful situations involved in most forms of school learning. Among the experiments which have yielded findings indicating that retroactive interference is unlikely to occur in school learning situations are ones by Ausubel *et al.* (1957, 1968), Hall (1955) and Mehler and Miller (1964). In a study by Howe and Cavicchio (1971) the authors argued that retroactive interference is most likely to occur in circumstances whereby subjects do not merely listen to or read the similar interpolated materials, but are required to produce the interpolated items themselves. The evidence for this suggestion was a finding by Howe (1970; repeated by Howe, 1972; Howe *et al.*, 1974) that learners are much more likely to remember items provided by themselves than items they attend to but do not produce. Howe and Cavicchio required subjects in experimental groups both to read and to recall a prose passage which was similar in content and structure to the original passage. The findings proved no evidence of retroactive interference.

Recently, however, the issue has been re-opened by researchers who have produced some results appearing to support the claim that retroactive interference may, after all, have a major influence in structured school learning situations. The findings of experiments by Anderson and Myrow (1971), Bower (1974), Crouse (1971), and Myrow and Anderson (1972), all provide support for the suggestion that retention of prose can be subject to retroactive interference, and Bower's (1974) evidence indicates that, at least for detailed information, interpolated similar prose materials may indeed interfere with retention of important semantic contents of a prose passage presented earlier. Bower required subjects to learn a short fictional biography. The experimental subjects also learned two further biographies of similar structure but with changed details. These subjects subsequently recalled the changed details less accurately than a control group who received dissimilar intervening passages, but their recall of details that were unchanged was improved.

The present experiment was designed to seek further evidence concerning the possible role of retroactive interference in situations whereby students learn information made available in prose form. One aim of the study was to determine whether Bower's findings could be replicated in a task requiring the learning of different kinds of information. Another was to acquire more precise information concerning the detailed nature of any interference effects.

METHOD

Subjects and Materials.

Eighteen university students participated. They were chosen at random from a voluntary subject pool. The passages of prose used in the experiment were constructed as follows: Items of information about a fictitious country, 'Perovia,' were arranged to form a continuous passage 15 sentences long, the average sentence length being 16 words. Each sentence could be divided into two 'idea units.' Examples are: "Apples and grapes are the main agricultural crops/grown in the South of Peruvia," and "State education has been provided for 60 years,/and is compulsory after the age of 5." Similar interpolated passages were created by changing 20 of the detailed information units in an original passage. For the control group, two entirely different interpolated passages were constructed. Each passage was typed out, and a cardboard 'window' was used to display one sentence at a time.

Procedure.

The students, who were tested individually, were assigned at random to the experimental and control groups. Every passage was presented twice, for five seconds per sentence, with a 10-second pause between the two presentations. The subjects were told to attempt to memorise the individual sentences and also to attempt to relate their contents to the overall text. Following the two presentations of each passage, the student was asked to read aloud from a table of random numbers.

After the first passage, a free recall test was administered, in which students tried to reproduce the 15 sentences, so far as possible in the correct order. They were told to reproduce the information content if they could not recall it verbatim. Six minutes were allowed for free recall, students being told when only one minute remained. Following free recall a cued-recall test was administered, consisting of 20 short-answer questions. Two-and-a-half minutes were allowed for this test. Each student then studied two further passages, following an identical procedure. After these passages were removed cued-recall tests were administered. The experimental group received passages concerning other fictitious countries, while the control group read the passages about German and Greek history. Within both groups the order of the passages was varied, in order to control for any inherent difference in difficulty. Following the cued-recall test after the third passage (i.e., the second interpolated passage), all subjects attempted a second free-recall test of the initial passage. Finally, they were given the cued-recall test once more.

Scoring.

In the cued-recall test each correct answer was awarded one point. Errors were classified as omissions, completely incorrect answers and intrusions. The intrusion category applied only to the performance of the experimental group. The scoring procedure for measuring free-recall test performance followed that used by Bower (1974). First, each recall attempt was scored for recall of the general facts and idea units in the passage, and secondly, the passage was scored for recall of specific facts.

RESULTS

Mean cued-recall test scores on the immediate and final (following the two interpolated passages and tests) occasions are shown in Table 1. Subtracting the immediate from the final scores gives a measure of the change that occurred. Retroactive interference was assessed by observing the differences between experimental and control groups in the change between immediate and final test scores.

TABLE 1

Mean Cued-Recall Scores (Out of 20) on the Immediate Tests and on the Test Administered Subsequently, After the Interpolated Passages were Presented.

	Experimental Group (N=9)			Control Group (N=9)		
	Correct Responses	Incorrect Responses	Omissions	Correct Responses	Incorrect Responses	Omissions
Immediate test	13·33	2·77	3·90	12·90	2·16	4·94
Later test	12·00	3·94	4·06	13·06	2·55	4·39
Change	−1·33	1·17	0·16	0·16	0·39	−0·55

Table 1 shows that whereas average scores by students in the control group were slightly (but significantly) higher in the final than in the immediate cued-recall test, those in the experimental group performed appreciably worse in the final test. The difference between the two groups in the changes between immediate and final test performance is statistically significant ($P < {\cdot}025$). In short, the cued-recall test scores support the assertion that retroactive interference can occur when two similar passages are interpolated between the original presentation of meaningful prose materials and the final test for recall of the contents.

On average, 1·4 of the 3·9 incorrect responses made by the experimental group on the final cued-recall test were classifiable as intrusion errors. When this figure is subtracted from the total average error score on the final test, the resulting figure, 2·5, is equivalent to the average number of errors made by students in the control group. However, over half of the intrusion errors occurred on questions in which answers had been omitted on the immediate cued-recall test, indicating that intrusion errors cannot fully account for the difference in test scores between the experimental and control subjects. Free-recall of the general facts in the passage was significantly higher ($P < \cdot005$) in the final test than in the immediate test for both experimental group and control group. The magnitude of the improvement (mean increases being 3·94 for the experimental group—15·72 to 19·66) and 4·39 for the control group—15·72 to 20·11) did not differ significantly between the groups.

DISCUSSION

The cued-recall test data obtained in the present prose-learning experiment provide evidence that retroactive interference can occur with meaningful material. Together with the evidence of Bower (1974), who used prose materials that were similar in form but different in content, the results provide support for the hypothesis that retroactive interference can affect the level of students' performance. Clearly, it is one among many factors which may influence performance, but these present findings indicate that retroactive interference may have to be reckoned in those school learning situations where similar materials are presented to the learner in close succession.

Several students allocated to the experimental condition spontaneously commentated afterwards that they felt the changes made in the specific details of the interpolated passages to be very confusing. Paradoxically, however, the individuals who commented thus tended to be among the highest scorers on the cued-recall tests. Possibly, those subjects who were most fully aware of the dangers of confusion were the most able to overcome the problem, perhaps by concentrating harder. It is possible that some *within*-passage retroactive interference may have occurred. Some of the responses given in the control group's cued-recall tests appeared to be intrusions from other parts of the same passage.

The failure of the free-recall test to detect the retroactive interference observed by the cued-recall method of assessment is not altogether surprising, since the latter provides a more sensitive measure of learning. The difference between the two patterns of test scores may help explain the failure of some previous experiments to provide evidence of retroactive interference. It is possible that the free recall procedures used in the previous studies have been insufficiently sensitive to detect differences in some detailed aspects of subjects' learning.

The present experiment has demonstrated that retroactive interference can influence learning where the materials learned are *very* similar. Although such close similarity is unlikely to be found in school learning situations, the time intervals over which fairly similar materials are presented are much longer than can be achieved in controlled experimental research. It does seem possible, therefore, that retroactive interference will affect the learning of prose passages in school, as well as in the laboratory.

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PARENT PARTICIPATION IN PRE-SCHOOL EDUCATION

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SUMMARY. 48 pre-school children receiving a four-month programme administered by mothers at home and organised through the local primary school or nursery were compared with 48 children receiving either the ordinary nursery routine or no intervention between tests. Children receiving the parent programme made significant gains on the Stanford-Binet and Reynell Developmental Language Scales. Children receiving nursery enrichment, but no parent programme, made significant gains also on the Stanford-Binet, but not on the RDLS. Children receiving no intervention between tests did not make significant gains on either measure. No relationship was established between Stanford-Binet gains and social class.

INTRODUCTION

ENVIRONMENTAL stimulation is thought to have its most potent effects during periods of maximum growth (Caldwell, 1962). Since the preschool period is regarded as the fastest growth period for language and cognitive development (Bloom, 1964), it is receiving increasing attention (Tizard, 1974) and preschool enrichment is rapidly advancing its claims as a necessary (Hunt, 1964) but not sufficient (Bernstein, 1970) element in compensatory education. Both day-care, and home-based programmes are proliferating (Chazan, 1973; Blackstone, 1973; and Gordon, 1968). Differences in attainments are believed to reflect differing treatments in the early years (Kagan, 1970). Consequently mother-child interactions during the preschool period are becoming an important area of investigation (Bernstein, 1973; Hess and Shipman, 1965) and a number of studies encouraging mothers to take a more active part in their children's education are reviewed by Schaefer (1972). The present work is to be viewed in the context of such studies but with the added aim of simultaneously fostering links between mothers and their preschool children's future school (Bernstein, 1970).

METHOD

The aim of this study was to investigate the effects on 3- and 4-year-old children of exposure to a four-month programme administered by mothers at home and organised through the local primary school or nursery. It was expected that significant cognitive and linguistic gains would accrue from participation in the programme.

Sample.

Ninety-six children of 3 or 4 years and their mothers were drawn from two mixed urban areas in Renfrewshire some 20 miles apart. Each area included a district thought to have many of the characteristics of Educational Priority Areas (Halsey, 1972). Each group included children both from the EPA section and from the area generally.

Design.

A before and after experimental design was adopted. There were four experimental groups (two being school-based and two nursery-based) and two distal control groups to minimise any diffusion effect (Gray and Klaus, 1970).

Characteristics of the groups are summarised in Table 1.

TABLE 1

SUMMARY OF GROUPS.

Group	Age	N	Based	Area	Intervention
A	4 years	16	School	Same Area	Programme Administered by Mothers.
B	3 years	16	School		
C	4 years	16	Nursery (PM)		Nursery Routine +Programme Administered by Mothers.
D	4 years	16	Nursery (AM)		Nursery Routine only.
E	4 years	16		20 miles from above area	No intervention between Tests.
F	3 years	16			

Thus, groups A, C, D and E were matched for age (4-year-olds) as were Groups B and F (3-year-olds). In addition all groups were matched for sex (half of each group being boys), social class (half of each group being Class V and the other half Classes II, III and IV on the Registrar General's classification) and English Picture Vocabulary Test (EPVT) scores (see Table 2). The 16 children in each group were augmented by three substitutes to provide for possible attrition. The school-based groups were recruited first. Health visitors supplied the names of all children between 3 and 5 years who would eventually attend the school in question. When those already attending the nursery were eliminated, all of the others were invited both by a letter from the school and by a personal visit from the health visitor to participate in the school-based procedure. Groups A and B were made up from those who agreed to participate and volunteers additional to requirements were given the programme in a non-experimental way. Finally, nursery groups (C and D) and the non-intervention groups (E and F) were matched with those already chosen for groups A and B. All 120 children in the nursery were then tested on the EPVT in order to select separate groups from the morning and afternoon children which would best match the school-based 4-year-olds. The two distal control groups (E and F) were matched with the school-based groups (A and B) respectively. The names were again taken from the health visitors' lists and matching involved testing almost double the required number of control group children on the EPVT.

The intervention period ran from February, 1974, to June, 1974, with a two-week break for the Easter Holidays and testing was completed within a month before and after this period. Ten substitutes were used with not more than two being required for any group.

Evaluation.

Primary: Primary evaluation included testing the children before and after the four-month intervention period on the Stanford-Binet (S-B), Reynell Developmental Language Scales (RDLS) and EPVT. Mothers' impressions of the programme were elicited at post-test by means of unstructured interviews. Each week mothers submitted a record of their daily efforts with the child together with details of any life events which might have affected the child's progress.

Secondary : Secondary evaluation included pre- and post-testing of maternal attitudes by means of "A Measure of Mother's Communication and Control " (Brandis and Henderson, 1970). Stott's Systematic Interview Guides (1967) were administered by health visitors before the programme and the Behaviour Section completed again at post-test. In the case of the nursery groups only, the Pre-School Inventory (Caldwell, 1970) and the Social Behaviour Rating Scale (Herbert, 1973) were administered among the pre-and post-tests. The present paper is concerned with primary evaluation only.

The Pre-School Inventory and the Social Behaviour Rating Scale were completed by nursery staff while the Systematic Interview Guides and "A Measure of Mother's Communication and Control " were administered by the health visitor who normally visited the family. The EPVT was administered by school and nursery teachers and a research assistant. The S–B and RDLS were administered by four child guidance psychologists testing the same proportion of each group in pre- and post-test with the exception that one psychologist was unavailable at post-test and replaced by the research assistant. The design was not explained to the testers from the child guidance department although they may have gained clues from casual comments by mothers. While the research assistant and the author were naturally aware of the design, neither they nor the other testers adverted to pre-test results, at post-test. Moreover, apart from half-a-dozen logistically necessary exceptions, testers did not test the same children at pre- and post-tests. Thus, testers had no expectations with regard to particular children.

THE NATURE OF THE INTERVENTION

School-based Groups.

The intervention procedure in respect of the two school-based groups (A and B) was one devised by the author in 1972 and now in operation in eight Renfrewshire schools at the request of head teachers.

The experimental preschool children and their mothers were asked to attend the school each Thursday at 3 p.m. from February, 1974, to June, 1974. While the children played under the supervision of auxiliaries, the mothers selected a book to read at home to the children from a supply provided by the primary adviser and the county library. The mothers then had tea with the three infants' teachers who had volunteered for the project, in an effort to enhance relations between mothers and teachers. After tea, mothers met in groups chaired by teachers. Three mothers had two children involved and each teacher chaired a random group of 12 mothers. In addition to story books, each mother was provided each week with a typed unit of a programme devised by the child guidance department for mothers to administer at home. This programme prescribes materials likely to be available in all homes and deals with general vocabulary, simple number and relationships of time, space and size. Mothers were asked to spend a total of 30 minutes a day on the book and programme. At the group meetings each mother was asked to say how she fared with the child during the previous week and received suggestions from the other members.

Discussion at group meetings often ranged over wider aspects of education and child rearing and mothers appeared to be sufficiently reinforced by these meetings to persist in the programme.

Nursery-based Groups.

Group C children attended (afternoons only) a nursery school in the same area as the above school. In addition to the normal nursery enrichment, these children received a parent programme organised in exactly the same way as the school-based children. In this case there were two groups of mothers (N=9 and 8 respectively) chaired by two nursery teachers. There was the disadvantage here that the teachers relating to the mothers were not the ones who would be teaching these children on their entering primary school. Nevertheless, it was felt that the procedure did represent one viable pattern of parental involvement in nursery education. The children of Group D attended the nursery in the mornings only and received no experimental intervention beyond the normal nursery curriculum. All of the nursery children had been in the nursery for five months when the experiment began in February, 1974.

Control Groups.

As already indicated, these children lived in a separate town from the experimental children and in an area which appeared similar in social composition to the experimental area. The parents of the control children were asked to allow us to monitor the children's development over a four-month period. They were promised that we would, where possible, make suggestions after the post-test for any needs we identified in their children.

RESULTS

Pre- and post-test mean scores and standard deviations are shown in Table 2. Statistical treatment of gains made by the six groups on the EPVT S–B and RDLS tests was by means of a 3×2 analysis of variance following the model shown in Table 3.

English Picture Vocabulary Test.

EPVT gains were significant only in the case of school-based 4-year-olds (Group A), ($F=19{\cdot}0$, $P<{\cdot}01$).

Stanford-Binet.

The Stanford-Binet was regarded as the principal evaluation instrument since it is the most frequently used test with young children, is suited to longitudinal study, and correlates highly with school attainments. The programme effect was significant for all three groups (A, B and C) ($F=38{\cdot}3$, $P<{\cdot}01$). The nursery effect (Groups C and D) was also significant at the ·01 level ($F=9{\cdot}1$). The age effect was, however, non-significant ($F=0{\cdot}1$).

Reynell Developmental Language Scales.

Gains made in language comprehension by the parent-programme groups (A, B and C) were significant ($F=5{\cdot}5$, $P<{\cdot}05$) while the age and nursery school effects were non-significant. On the 'expression' sub-scale gains by the parent programme groups (A, B and C) were significant. ($F=33{\cdot}5$, $P<{\cdot}01$). Age and nursery school effects were again non-significant.

Stanford-Binet and Social Class.

Gains made by children in the various social classes were compared by means of independent 't' tests in respect of (*a*) all subjects, (*b*) programme subjects and (*c*) non-programme subjects. Class V children were compared with IV, III and II and classes IV and V were compared with III and II. In all instances the 't' ratio was not significant. There was thus no discernible relationship between gains on the Stanford-Binet and social class. It is also important to note that gains made by the distal control groups (E and F) were not significant on any measure.

TABLE 2

PRE- AND POST-TEST MEANS AND STANDARD DEVIATIONS.

Group	Age	E.P.V.T.				Binet				Reynell Comp.*				Reynell Exp.*			
		Pre		Post		Pre		Post		Pre		Post		Pre		Post	
		M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)
A School-based	4	96·7	(12·0)	109·2	(11·8)	100·9	(11·0)	109·4	(7·6)	0·16	(0·89)	0·97	(0·53)	–1·09	(0·95)	0·01	(0·68)
B School-based	3	103·8	(11·7)	107·7	(12·1)	111·9	(15·4)	120·4	(16·6)	0·35	(1·10)	1·3	(1·20)	–0·56	(1·19)	0·34	(0·70)
C Nursery P.M. (Programme)	4	97·3	(12·3)	102·9	(11·3)	100·1	(12·6)	112·9	(15·3)	0·26	(0·87)	0·81	(0·93)	–0·44	(0·91)	0·01	(0·99)
D Nursery A.M. (no Programme)	4	99·1	(10·9)	105·8	(13·3)	106·6	(15·4)	112·4	(13·2)	0·06	(1·10)	0·73	(1·17)	–1·02	(0·97)	0·31	(0·76)
E Control	4	98·0	(12·3)	98·2	(16·3)	102·3	(7·6)	101·8	(15·6)	–0·11	(1·22)	0·28	(1·23)	–0·76	(1·21)	–0·76	(1·08)
F Control	3	101·1	(12·3)	102·3	(12·2)	112·2	(14·5)	111·4	(13·5)	0·38	(0·74)	0·58	(0·75)	0·04	(0·72)	–0·09	(0·69)

* Reynell results are in the form of Standard Scores from −3 to +3.

TABLE 3

ANALYSIS OF VARIANCE.

	Programme	No Programme	Total
3-year-olds	B (16)	F (16)	(32)
4-year-olds	A (16)	E (16)	(32)
4-year-olds (Nursery)	C (16)	D (16)	(32)
Total	(48)	(48)	(96)

DISCUSSION

Although the EPVT was intended as a matching test only, it was decided to include it in the post-tests since the results could be conveniently obtained. The school-based 4-year-olds (A) alone made significant gains on this test. There is no ready explanation for this.

That all parent programme groups made significant gains on the Stanford-Binet was not surprising to the author who had similar results on previous projects where the mother was asked to assume the principal responsibility for her preschool child's educational advancement (Donachy, 1972, 1974). Significant Binet gains were also attributable to nursery attendance although children had been at the nursery for five months when the project began and one might expect gains to have occurred by that time (Weikart and Lambie, 1970; Williams, 1974). It is possible that nursery staff unwittingly paid more attention to Group D children, especially since they completed a behaviour rating scale in respect of them before and after the intervention period. In retrospect the staff felt they had placed these children under closer scrutiny from the point of view of social and emotional indicators but they were not conscious of having made extra efforts at cognitive stimulation. The Binet results failed to indicate any preference for intervening at three or four years.

On both the comprehension and expression scales of the RDLS only the parent programme children made significant gains. The amount of talk with adult identification models was probably unequal between programme and non-programme children (Cazden *et al.*, 1970). The quality of adult-child talk probably differed also since programme mothers were being encouraged to raise the semantic level of their verbal interaction with their children (Bing, 1963). The expression scores should, perhaps, be treated with greater caution than the 'comprehension' scores in view of the inhibiting effect of the test situation on young children's speech (Cazden, 1974). Nevertheless, there was no obvious evidence of undue inhibition on the part of the children in this sample and the impression is that these scores did represent a genuine increase in verbal facility on the part of the parent programme groups.

Children in all social classes made gains of about the same size on the Stanford-Binet and this agrees with the findings of Williams (1974). The lack of a social class effect is all the more striking in view of the fact that some differences might have been expected due to regression effects. Thus, preschool programmes do not reduce the class gap unless restricted to 'disadvantaged' children in an unacceptably stigmatising way. These results are in opposition to threshold theories of environmental stimulation. Jensen (1967) wrote, for example, "Environmental changes or manipulations seem to affect to any marked degree only those children whose social environments are quite wretched and clearly below what is presumably the environmental threshold for the normal development of genetic intellectual potential." Perhaps Hunt (1964) is nearer the mark in asserting that we have hardly begun to explore the potential of all preschool children.

TABLE 4

ROUGH CLASSIFICATION OF MOTHERS' COMMENTS IN UNSTRUCTURED INTERVIEWS.

Category	Groups A and B School-Based (32)			Group C (Nursery-Based (16)			Totals (48)		
	Yes	No	N.M.	Yes	No	N.M.	Yes	No	N.M.
Child liked visits to school	25	3	4	Not	applica	ble	25	3	4
Child liked books	28	0	4	11	0	5	39	0	9
Mother liked books	28	0	4	11	0	5	39	0	9
Child liked sheets	26	2	4	11	0	5	37	2	9
Mother liked sheets	26	2	4	11	0	5	37	2	9
Mother read to child before programme	27	5	0	11	2	3	38	7	3
Mother changed reading method because of experience of programme	14	13	5	8	4	4	22	17	9
Mother saw new teaching opportunities in the day's activities	25	4	3	12	0	4	37	4	7
Mother found group meetings valuable	21	4	7	12	0	4	33	4	11
Mother now feels more at home in school	17	0	15	Not	applica	ble	17	0	15
Mother uses programme ideas with other children	24*	0	8	10†	2	4	34	2	12

N.M.—Not Mentioned.

*15 Siblings.
9 Others.

† 5 Siblings.
5 Others.

Mothers' Comments on the Programme.

Table 4 presents a rough classification of common elements in the comments on the programme elicited from mothers in unstructured interviews at post-test. The fact that the pre-school children enjoyed their weekly visits to the school will presumably smooth their formal entry at five. Although most mothers read to their children before the programme, they were led to change their method in the direction of making the reading session much less passive for their children. A number of non-experimental children seem to have benefited from both vertical and horizontal diffusion and the experimental children presumably profited from their mothers' new sensitivity to the natural teaching opportunities in the ordinary activities of the day. The mothers' obvious awareness of these and other benefits in the school-based system may have occasioned a modification in their attitudes towards their children's education in both the broad and narrow sense of the term. This gives rise to the hope that these mothers will continue to support their children's educational advance and suggests that parent programmes have the best chance of minimising the well-known decrement that occurs when programmes end (Kohlberg, 1968). Further investigation of the effects of programmes on the parents would appear to be a very worthwhile task (Bruner, 1970; Kagan, 1970).

Teachers.

Teachers involved with the school-based and nursery groups were not interviewed formally but in a general discussion of the programme they were unanimous in asserting that they found contact with parents much easier and more valuable than they anticipated. The infant teachers welcomed the opportunity of discussing with parents many broader issues concerning school readiness and felt their perspective improved by their experience, albeit second-hand, of preschool learning.

Thus, in addition to the cognitive and linguistic gains accruing to the parent programme children which at least in the former case were not related to social class, nursery education appeared to be making a measurable contribution to cognitive development. Perhaps more important than the measured gains which may not last, however, were the gains in relationships. Mothers and teachers were aware of a wide range of benefits, not least that their co-operative venture was viable in the context of the present educational system.

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SIZE OF SCHOOL, SOCIO-ECONOMIC HARDSHIP, SUSPENSION RATES AND PERSISTENT UNJUSTIFIED ABSENCE FROM SCHOOL

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INTRODUCTION

SUMMARY. Information was obtained from 30 comprehensive schools and their feeding primary schools about all children who missed at least 50 per cent of possible attendances in the first half of the 1973 autumn term. Results showed no major differences in persistent absentee rates between the reception year at first schools and the final year at middle schools. In contrast, the figures for comprehensive schools showed a sharp rise, with a peak in the fifth year. Truancy accounted for only a small proportion of unjustified absence in all age groups. No association was found between the size of a comprehensive school and the number of persistent absentees. On the other hand, persistent absenteeism was closely associated with socio-economic hardship in the school's catchment area though there is reason to suppose that variables within individual schools also influence the figures. The number of children suspended from a school was associated neither with a high incidence of socio-economic hardship, nor with large schools, nor with high persistent absentee rates. In contrast, high suspension rates were associated with former selective schools. It is concluded that suspension rates may not reflect the amount or the degree of deviant behaviour in a school.

INTRODUCTION

A NUMBER of studies have investigated the incidence of absence from school. Thus, the Plowden Report (1967) found the average overall percentage of attendance in primary schools in 1964-65 was about 93 ; in secondary schools the percentage was approximately the same for boys, and somewhat less for girls (Bransby, 1951 ; West Riding, 1962)

The majority of these absences were attributable to illness or some other unavoidable cause (Bransby, 1951). According to the Plowden Report (1967) primary school teachers believed that at least 4 per cent of children absent at any one time ought to have been in school. More recently (DES, 1974) a national survey of attendance on one day in January, 1974, in middle and secondary schools showed that 10 per cent of all pupils aged 12 or over were absent, and of these 2 per cent were apparently absent without legitimate reason (23 per cent of those absent). The highest percentage of absence and of unjustified absence was amongst adolescents aged 15 (14 per cent and 5 per cent). Tyerman (1968) points out that more children are kept from school than play truant, prosecutions for the former offence being about five times as common as for the latter. In 1963-64 the overall absence rate was about 10 per cent, but less than 0·1 per cent of the children on roll were prosecuted for truancy.

Little, however, is known about the incidence and causes of persistent absenteeism for reasons other than organic illness. Similarly, very few studies have tried to isolate the variables associated with persistent absenteeism. Despite the dearth of evidence there is an abundance of folklore. Thus, large (and by implication impersonal) comprehensive schools are popularly supposed to have greater absentee problems than smaller (and by implication more personal) secondary schools (Jones, 1974). Similarly, a powerful educational and political lobby maintains that these schools have greater discipline problems. Although the connection between social class and behavioural disturbance is not clear-cut (Douglas, 1964 ; Douglas, Ross and Simpson, 1968) the same beliefs apply, with rather more evidence (Wedge and Prosser, 1973), to schools situated in culturally deprived areas of large cities. Now if it is indeed the case that socially deprived areas and large schools are in themselves causes of absenteeism and deviant behaviour, then it may be predicted that the comprehensive schools with the highest absentee rates and the highest proportion of pupils suspended for unacceptable behaviour will be large schools in depressed areas, while the reverse will be true for small schools in socially privileged areas. One principal aim of this survey was to test these hypotheses ; the other was to investigate the extent and causes of persistent unjustified absence from school.

METHOD

All comprehensive schools and their feeding primary schools in a large Northern city provided details about children who had missed an arbitrary figure of at least 50 per cent of possible attendances in a seven-week period at the beginning of the autumn term, 1973. Data for the Roman Catholic schools are not included, since their re-organisation into a comprehensive system is not complete. In addition special schools and one further comprehensive school are excluded from the results ; (data were not available for nearly 75 per cent of pupils at the latter owing to a catchment area anomaly involving another authority). With these exceptions the survey was city-wide, and covered 30 comprehensive schools and their feeding primary schools, with a total population of 82,779 pupils of compulsory school age (52,908 in primary schools and 29,871 in comprehensives). The education welfare officers who knew both children and families then stated the reasons for the absences according to categories detailed below. All cases where absences were due solely to organic illness were discarded from the subsequent calculations, and are not included in any of the figures given in this paper.

The size of each of the comprehensive schools in the survey was taken as the number on roll at the beginning of the academic year, excluding adolescents above the minimum school-leaving age. The number of children receiving free school meals was taken as a measure of the incidence of socio-economic hardship in the school's catchment area. Details about all children who had been suspended from comprehensive schools for more than a week in the period May, 1973—April, 1974, were collected from Education Department records.

RESULTS

Extent of Persistent Absence.

Table 1 shows the percentage of persistent absentees for each age group. The city's schools are in the process of reorganising primary education into first and middle schools from infant and junior, with transfer at the ages of 8 and 12 instead of 7 and 11. Hence, in 1973, only about 50 per cent of children reached their 12th birthday in their first year at a comprehensive; the rest entered secondary education from middle schools and were 13 in their first year.

These figures indicate that the persistent absentee rates remain consistently below 1 per cent throughout the primary school years. There is a rise of nearly 300 per cent over the average primary school figure in the first *full* year at comprehensive schools ; nevertheless, the fact of transfer to a different (and larger) school does not *per se* appear a satisfactory explanation. This is because the persistent absentee rate for children in year 1 at comprehensive schools is not markedly higher than the average for primary schools and is, in fact, lower than that of their exact contemporaries in year 4 in middle schools.

TABLE 1

NUMBER AND PERCENTAGE OF PERSISTENT ABSENTEES.

School	Age-group	Number of Absentees	Percentage of Roll
Infant or First	5*	24	0·6
	6	40	0·5
	7	18	0·2
Junior or Middle	8	25	0·3
	9	26	0·3
	10	33	0·4
	11	30	0·4
	12	37	1·0
Comprehensive	12	15	0·5
	13	89	1·3
	14	91	1·4
	15	154	2·3
	16	290	4·4
Overall Primary		233	0·4
Overall Comprehensive		639	2·1

* The number of children in reception classes was estimated as 50 per cent of those in other years.

The sharp rise in absenteeism in the final year of compulsory school attendance is perhaps not altogether surprising in view of the fact that autumn, 1973, was the start of the first year in which the minimum school leaving age was raised from 15 to 16. In 11 of the 30 schools the number of persistent absentees in year 5 was as great or greater than that in the three previous years combined. (In one extreme case the ratio was 21 : 2). However, some, though not all, of the schools had relatively low overall rates.

TABLE 2

PERSISTENT ABSENTEES FOR WHOM ILLNESS WAS A PARTIAL EXPLANATION.

School	Age-range	Number of Absentees	Proportion with illness
First, Infant and Junior 1	5—8	32	0·41
Junior, Middle and Comprehensive 1	9—12	34	0·41
Comprehensive	12—16	156	0·28

In four schools over 10 per cent of pupils in the fifth year met the criterion of 50 per cent of absences without a legitimate reason. Interestingly, only one of them was among the four schools with the highest proportion of children receiving free school meals. Although these figures exclude children whose absence was attributable entirely to organic illness, they do include children with

' psychosomatic ' illness (diagnosed by a general practitioner, psychiatrist or school medical officer) and also children whose absence was partly, though not entirely, due to illness. Table 2 reports the mean number of persistent absentees in each year-group and the proportion of absentees for whom illness (excluding psychosomatic illness) was a partial explanation. It will be noted that the proportion of children with some illness is smaller in comprehensive schools. This point is referred to again in the next section. All subsequent results were computed from the complete group.

Reasons for Absence.

The education welfare officer who knew the child and his family stated the reasons for the unjustified absences according to the categories in Table 3.

TABLE 3

REASONS FOR PERSISTENT ABSENTEEISM.*

Reason	Percentage Occurrence	
	Primary and First-year Comprehensive	Second to Fifth-year Comprehensive
With parents' knowledge, consent and approval	24·2	24·3
Socio-medical reasons (e.g., ' no shoes ')	10·5	2·7
' School Phobia '	1·2	4·2
Parents unable or unwilling to insist on return	16·1	26·0
' Truancy '	2·4	11·2
Psychosomatic illness	4·4	3·8
Mixed reasons, but including some illness...........	41·2	27·8

* Excluding prolonged organic illness.

(Table adapted from one previously published in *Times Educational Supplement*. Details of the coding system are available from the author.)

Where more than one category overlapped, the category thought most relevant was given. It will be noted that truancy, defined as absence without the knowledge or consent of the parent, accounted for little more than 2 per cent of persistent absentees in primary school children, and 11 per cent in comprehensives. In contrast, the two categories of absence with parental knowledge accounted for over 40 per cent of all cases in both primary and secondary children, while over 25 per cent in each case were assigned to the ' mixed ' category.

The reliability and validity of the figures given in Table 3 must be regarded with caution. Nearly 30 education welfare officers were involved. Inevitably they differed widely both in how well they knew the children and their families, and also in the ways they viewed explanations for absence. It was not possible to obtain satisfactory evidence on inter-rater agreement ; in most cases only one education welfare officer knew the family, and it is unusual (especially in comprehensives) for teachers to make home visits. Further, over a seven-week period it is difficult to exclude the possibility of illness as a partial explanation for absence. Few general practitioners would be willing to distinguish with confidence between a respiratory infection for which the child should remain at home for a week, a mild cold which is exaggerated by an anxious parent or a parent who is 'covering up' for the child, and a recurrent condition which is psychosomatic in origin. This problem is obviously much more difficult for an education welfare officer. It may well be that the 'school phobia' category is under-represented, and that there was a tendency to accept illness as an explanation more readily for younger children than for adolescents.

Despite these reservations, Table 3 does suggest that truancy is seldom a reason for persistent absence from school, whereas the opposite may be true of factors within the home. This has obvious implications for the training of education welfare officers.

Association with other Variables.

In an attempt to identify some of the variables associated with persistent absenteeism in comprehensive schools, the proportion of persistent absentees in each school was correlated with the following: the number of pupils on roll; percentage of children receiving free school meals; and the number of children suspended or permanently excluded from each school for more than one week on account of unacceptable behaviour in the course of the year May, 1973—April, 1974, expressed as a percentage of the number on roll. Pearson product-moment correlation coefficients are given in Table 4. Attempts to extract further information by computing a series of first order partial correlation coefficients did not prove fruitful, and no important changes in correlation were obtained.

TABLE 4

RELATIONSHIPS BETWEEN VARIABLES IN COMPREHENSIVE SCHOOLS.

Variable	Absentee Rates	Free School Meal Rates	Exclusion Rates
Number on Roll	—·22	—·08	—·21
Absentee Rates		·80*	·13
Free School Meal Rates			·07

* $P < \cdot 01$.

It will be noted from Table 4 that a non-significant negative correlation was obtained between persistent absenteeism and the size of school as measured by the number on roll. This was not an artefact created by homogeneity of school size; the range was from 560 to 1,779 (mean=996; SD=319). In contrast, socio-economic hardship in the school's catchment area, as measured by the number of children receiving free school meals, showed a high correlation with persistent absence ($r = \cdot 80$). The small negative correlation between persistent absenteeism and size was not greatly altered when the effect of free school meals was held constant ($r_{12 \cdot 3} = -\cdot 26$). The results suggest that exclusion from comprehensive schools is not associated with any of the three indicators chosen. Moreover, it is unlikely that the lack of relationship between exclusion and absenteeism is because the most deviant children in schools with high absentee rates avoid exclusion by simply failing to attend in the first place. In fact, few of the children who *were* excluded had a history of poor attendance.

The possibility of carrying out a correlational analysis between these variables and the categories described above was prevented by unsatisfactory reliability of the categories and small numbers when categories were analysed separately by schools.

The Schools' Contribution.

The results presented above indicate that an important variable associated with persistent absentee rates is the number of children receiving free school meals. Yet this tells us nothing about the differences, if any, between schools in similar socio-economic catchment areas. Do some have unexpectedly high, or low, absentee and exclusion rates ? A preliminary attempt to investigate this question was made in two ways :

(*a*) Persistent absentee and exclusion rates in former selective (grammar or technical) schools were compared with those in former secondary modern schools. To eliminate possible bias caused by the nine former selective schools tending to have fewer children on free school meals, each one was compared with the former secondary modern schools which had the closest proportion of children receiving free meals. The correlation between absentee rates in the two groups was positive and significant (r=·79 ; P<·05), indicating that they do not differ in any consistent way.

To compare exclusion rates in the two groups, the Mann-Whitney U test was preferred to Pearson's product moment coefficient owing to the high number of zero returns in the former secondary modern group (seven as opposed to two for the former selective schools). Using the correction for ties the result indicated that former selective schools excluded significantly more pupils (U=15 ; z=2·41 ; P<·01).

(*b*) If variables within a school exert little influence on the incidence of persistent absenteeism, we should predict a high correlation between the absentee rates in the 30 comprehensive schools and those of their feeding primary schools.

Since comprehensives and their feeding primaries had similar proportions of children receiving free school meals, it was possible to test the hypothesis that there is some consistent relationship between their absentee rates apart from this common factor.

TABLE 5

RELATIONSHIP BETWEEN ABSENTEEISM IN COMPREHENSIVE SCHOOLS AND FEEDING PRIMARY SCHOOLS.

Variable	(2) Absentee Rate in Comprehensives	(1) Absentee Rate in Feeding Primaries
Absentee Rate in Feeding Primaries	·65*	
Free School Meal Rate in Feeding Primaries (3)	·66*	·88*

* P<·01 r 12·3=·196

Table 5 shows that we are, in fact, able to reject this hypothesis. The correlation between free school meals and persistent absenteeism in primary schools (r= ·88) is consistent with that in comprehensives (r= ·80). Although the correlation between persistent absenteeism in comprehensives and primaries (r= ·65) is positive and significant ($P < \cdot 01$), this result is attributable to the contribution of free school meal rates in the primary schools. When this is held constant the correlation remains positive, but no longer approaches significance ($r_{12\cdot3} = \cdot 20$).

DISCUSSION

The results presented in Table 4 lent no support for the initial hypothesis that persistent absenteeism is a greater problem in large schools than in small ones, nor for the hypothesis that large schools and schools in areas of socio-economic hardship need to exclude more pupils on disciplinary grounds than small schools or schools in socially privileged areas. There is evidence, on the other hand, that socio-economic hardship in a school's catchment area *is* associated with persistent absenteeism, though other factors may also be operating.

The incidence of persistent absenteeism recorded in this survey almost certainly underestimates the true position. The information was collected in the first half of the autumn term, when school attendance is possibly higher than at other times of the year (Sandon, 1961). ' Hidden truancy,' caused by children who attend school until the daily register has been taken and then leave, may have further depressed the figures. On the other hand, 1973-74 was the first year in which the school leaving age was 16. It will be interesting to see whether the fifth year returns remain at the same high level in subsequent years when, perhaps, fewer adolescents may resent having to remain at school.

The number of children excluded from comprehensive schools for more than one week in the period May, 1973—April, 1974, was 34. This was, unfortunately the only period for which records were readily available. The criterion of one week was selected as certain head teachers were known to use short-term exclusion principally as a means of persuading the parents of problem children to visit the school ; the intention was to eliminate the majority of these children from the survey. A further four children were excluded from primary schools and three from special schools. York *et al.* (1972) reported that 31 children had been excluded from Edinburgh schools in the two years August, 1967—July, 1969. Their sample did not include children who had been suspended for only a few days. Twenty of the children excluded in the present survey were in their fifth year at a comprehensive ; they would presumably have left school at the age of 15 if they had been able to. When adjustments are made for this group and for a further group whose suspension, though longer than a week, was not indefinite, the incidence of exclusion from school appears roughly the same in the two cities.

York argued that exclusion was " by no means the result of an arbitrary decision by a teacher," and emphasised the children's intellectual and educational backwardness, their social deprivation and their disturbed families. While not necessarily inconsistent with these conclusions, the present survey does suggest that variables within a school may also influence the decision whether or not to exclude. For instance, former selective schools excluded significantly more pupils than former secondary modern schools, and one wonders whether this reflects their relative difficulties in adjusting to comprehensive reorganisation.

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ARE COMMON SENSE DECISIONS DETERRING LEARNING ?

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SUMMARY. The comparison of data from two vocabulary-learning studies involving a total of 2,483 males and females in the fifth and sixth grades suggests that 'common sense' decisions regarding the selection and assignment of learning materials may be inefficient if not detrimental. There is evidence to postulate that low ability pupils are the primary recipients or victims of the less effective materials. The data suggest that oversimplified learning materials may yield negative transfer and thus actually deter learning.

INTRODUCTION

IN a study designed to examine the effects of student-selection *versus* teacher-assignment of learning materials it was reported that, contrary to prediction, students' performance on a vocabulary task was significantly lower in the student-selection condition (Clifford, 1975). The data from this study coupled with the apparently conflicting evidence from a previous study (Huber, 1970) led the author to propose a model in which performance, given option, is viewed as a function of " the importance, valence, or substantialness of the option " and " the degree to which one anticipates having to make options and accept their consequences." While the model provided a plausible explanation for the discrepancies between the two experiments, it was based on the assumption that the differences among the materials used to provide option in Clifford's study were trivial; and that the presence or absence of choice *per se* was the major determinant of performance. This assumption was based on pilot data.

Subsequent reanalyses of Clifford's data, however, indicated that choice and assignment of materials were significantly related to students' abilities; and that the frequency with which each of the available materials were used (chosen by students or assigned by teachers) differed substantially with the two treatments. The nature of these findings suggested that both teachers and students had perceived some materials to be more facilitative of learning than others.

Although comparability of materials is not a prerequisite for investigating the empirical question of whether student- or teacher-made decisions optimise performance, it was an assumption of the proposed model referred to above. Therefore, only if a powerful demonstration of no differences in materials can be provided, would it be appropriate to further examine the option-performance phenomena in terms of the model (Clifford, 1975). On the other hand, if it can be shown that the materials themselves are a determinant of performance, then that factor coupled with ability and the frequency with which each of the materials were chosen or assigned must be considered in an explanation of the initial findings. Thus, the following study was designed primarily to examine the effectiveness of the materials used in the initial study.

METHODS

Sample.

Thirty-two fifth grade classes, 32 sixth grades and six combined fifth- and sixth-grades located throughout the state of Iowa participated in this study. A complete set of data was collected from a total of 1,626 students; observations from another 123 students were discarded because of incomplete data, primarily due to absenteeism. Descriptive statistics for the sample with complete data are presented in Table 1.

Materials.

The materials were identical to those used in the option study (Clifford, 1975) and were based on a vocabulary unit entitled *Word Builder* (Clifford, 1971). This unit consists of a booklet of 10 study sheets each containing 20 words for a total of 200 vocabulary words. For each sheet there is a corresponding 10-item multiple choice test. These 10 tests yield a composite performance measure (having estimated KR-20's of ·95 and ·93 on comparable samples), with a maximum score of 100.

Three modified forms of the study sheets were prepared. Each form contained the vocabulary words of the original set for each of the 10 consecutive pages. In the previous study the four resulting forms, identified below, were given to teachers who either assigned one form to each student, or presented and explained the forms and then allowed each student to choose one. In the present study, however, each form identified one of four conditions:

(1) *List.*
This consisted of the original form with 20 words listed on each of 10 sheets.

(2) *Simple Association.*
Beside each word on the study sheets was an appropriate definitional association (e.g., arbitrary, without reason).

(3) *Story Context.*
The 20 terms per sheet were compiled in a brief story. Terms were underlined to identify them for study. The contextual setting provided no definitional clues (e.g., He didn't want *criticism* from his classmates for choosing an *arbitrary scheme*).

(4) *Error.*
This resembled the Simple Association condition with one exception: four of the 20 definitional associations per sheet were interchanged. Students were instructed to identify and correct them prior to studying.

The definitional associations provided in Simple Association and Error conditions were not identical to those found in the tests. For example, while the term ' accumulate ' was associated with ' gather ' on the study list, it was to be defined as ' collect ' on the accompanying quiz. Thus, successful performance required more than recognition in all conditions. The 10 tests were identical across conditions and yielded a composite performance (*P*) measure. A Retention (*R*) measure consisting of 50 items, five randomly selected from each of the 10 tests, served as a final assessment of the unit. A two-item measure of Perceived Learning (*Lr*) and a three-item measure of Task Liking (*Lk*) was designed to assess attitude. Each of these items provided for a forced-choice response given a three-point scale; a high score indicated positive affect.

Procedure.

Classes within grade level were randomly assigned to one of the four conditions. The six mixed classrooms were randomly assigned to maximise balance in the design ; two were assigned to each of two conditions while one was assigned to each of the remaining conditions. Teachers administered all instruments. A manual of instructions was provided to ensure uniformity of procedure, which basically was as follows : on each of 10 consecutive school days, the student was assigned one study list. He was informed that he could seek assistance from parents, friends or reference materials. Teachers were forbidden to help or assign class time for study. The student was encouraged to learn multiple meanings. In the Simple Association and Error conditions he was informed that the correct definition on the test to be administered the following day would not be exactly like the definitional association provided on the study list. Teachers scored the tests each day, provided feedback, and assigned the next study sheet. The tenth and final test was followed by the Task Liking and Perceived Learning measures. Two weeks later, without forewarning, students were given the Retention measure. Thus, this study consisted of a 4×2×2 (condition×sex×grade) design with four dependent measures (*P*, *R*, *Lk*, *Lr*).

Independent measures including ability level (IQ) and Standardised Grade Equivalency Scores (GE) on Iowa Test of Basic Skills were taken from school records where available.* A measure of Locus of Control, the Academic Achievement Accountability (AAA) Scale (Clifford and Cleary, 1972), was also administered.

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* IQs were unavailable for 5 per cent to 15 per cent of students and GEs for a slightly larger proportion, dependent upon grade and school. Means reported in Table 1 are, therefore, based on less than the N reported for the dependent measures. For this reason covariate analyses were not performed.

RESULTS*

Summary statistics for dependent and independent variables are presented in Table 1. Analyses of variance on *P* and *R* resulted in Treatment effects ($F=4{\cdot}4$, 3/1610, $P<{\cdot}005$ and $F=5{\cdot}5$, 3/1610, $P<{\cdot}001$ respectively) and Grade effects ($F=40{\cdot}4$, 1/1610, $P<{\cdot}001$ and $F=40{\cdot}9$, 1/1610, $P<{\cdot}001$ respectively). An examination of Figures 1 and 2 indicates *P* and *R* are relatively higher in List and Story Context as compared with Simple Association and Error. There is noticeable consistency to this pattern regardless of Sex or Grade. There were no two- or three-way interactions for either dependent variable. Analysis of variance on *Lr* yielded a Treatment and Sex effect ($F=3{\cdot}9$, 3/1610, $P<{\cdot}01$ and $F=23{\cdot}7$, 1/1610, $P<{\cdot}001$ respectively). The latter suggests girls perceived they learned more than boys. This confirmed the findings reported in the option study. The treatment effect is accounted for primarily by the relatively high ratings recorded in the List *versus* the Story Context and Error conditions. Analysis of variance on *Lk* showed a Sex effect ($F=11{\cdot}5$, 1/1610, $P<{\cdot}001$) and a Treatment×Grade interaction ($F=5{\cdot}8$, 3/1610, $P<{\cdot}001$). The nature of the Sex effect resembles that found for *Lr*; girls scored higher than boys. This also confirmed the findings of the option study. The Treatment × Grade interaction reported for *Lk* indicates that while sixth graders tend to express greater liking for List, Simple Association, and Story Context, than do fifth graders, the reverse is evidenced in the Error condition.

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* The univariate analysis reported represents least squares solution which allows for disproportionate cell frequencies.

TABLE 1

DESCRIPTIVE STATISTICS: MEANS AND STANDARD DEVIATIONS.

Experimental Condition	Sex	Grade	N	Dependent Variables				Independent Variables		
				P M (SD)	R M (SD)	Lk M (SD)	Lr M (SD)	IQ M (SD)	GE M (SD)	AAA M (SD)
List	M	5	102	69·5 (20·7)	38·4 (10·3)	6·3 (1·5)	5·2 (·9)	111·2 (16·6)	4·7 (1·2)	11·9 (2·6)
	M	6	114	73·2 (18·4)	40·4 (9·6)	6·4 (1·4)	5·1 (1·1)	105·9 (15·8)	5·4 (1·6)	12·0 (2·5)
	F	5	82	69·4 (19·1)	37·9 (10·2)	6·7 (1·3)	5·4 (·8)	109·2 (17·0)	4·7 (1·1)	12·1 (2·3)
	F	6	118	76·2 (12·8)	41·4 (8·5)	6·8 (1·2)	5·5 (·8)	108·0 (14·4)	5·6 (1·5)	12·0 (2·1)
Simple Association	M	5	93	61·8 (20·9)	35·0 (11·4)	6·4 (1·7)	5·1 (1·1)	104·8 (14·8)	4·3 (1·0)	11·3 (2·7)
	M	6	112	71·3 (19·8)	38·8 (10·2)	6·9 (1·3)	5·2 (1·0)	105·9 (13·4)	5·2 (1·3)	11·7 (2·5)
	F	5	120	67·4 (20·7)	36·3 (10·5)	6·6 (1·5)	5·2 (·9)	108·2 (14·3)	4·6 (1·0)	12·0 (1·9)
	F	6	117	71·8 (22·6)	38·7 (10·8)	6·8 (1·4)	5·3 (·9)	109·2 (16·3)	5·5 (1·2)	12·3 (2·0)
Story Context	M	5	111	68·7 (18·9)	38·3 (10·5)	6·1 (1·7)	4·9 (1·1)	108·0 (12·2)	4·6 (1·1)	12·0 (2·5)
	M	6	73	75·6 (19·0)	40·0 (11·5)	6·8 (1·5)	4·8 (·9)	111·7 (16·1)	5·4 (1·6)	12·3 (2·5)
	F	5	93	69·9 (18·2)	38·8 (10·1)	6·7 (1·4)	5·3 (1·0)	111·3 (11·8)	4·9 (1·0)	11·9 (2·4)
	F	6	81	75·0 (18·1)	40·9 (9·8)	6·9 (1·2)	5·2 (·9)	112·6 (15·8)	5·6 (1·5)	12·3 (2·1)
Error	M	5	96	63·6 (19·8)	34·1 (11·7)	6·6 (1·7)	5·1 (·9)	104·5 (14·4)	4·5 (1·3)	11·8 (2·2)
	M	6	96	72·2 (20·7)	39·8 (10·1)	6·3 (1·6)	4·9 (1·1)	108·0 (14·5)	5·4 (1·2)	10·9 (3·4)
	F	5	97	65·7 (23·1)	35·7 (11·0)	6·9 (1·3)	5·2 (·9)	109·6 (15·1)	4·7 (1·2)	12·2 (1·6)
	F	6	121	72·4 (21·4)	40·6 (8·9)	6·5 (1·5)	5·1 (1·0)	112·4 (15·6)	5·8 (1·2)	12·0 (2·2)

FIGURE 1

PERFORMANCE AS A FUNCTION OF TREATMENT.

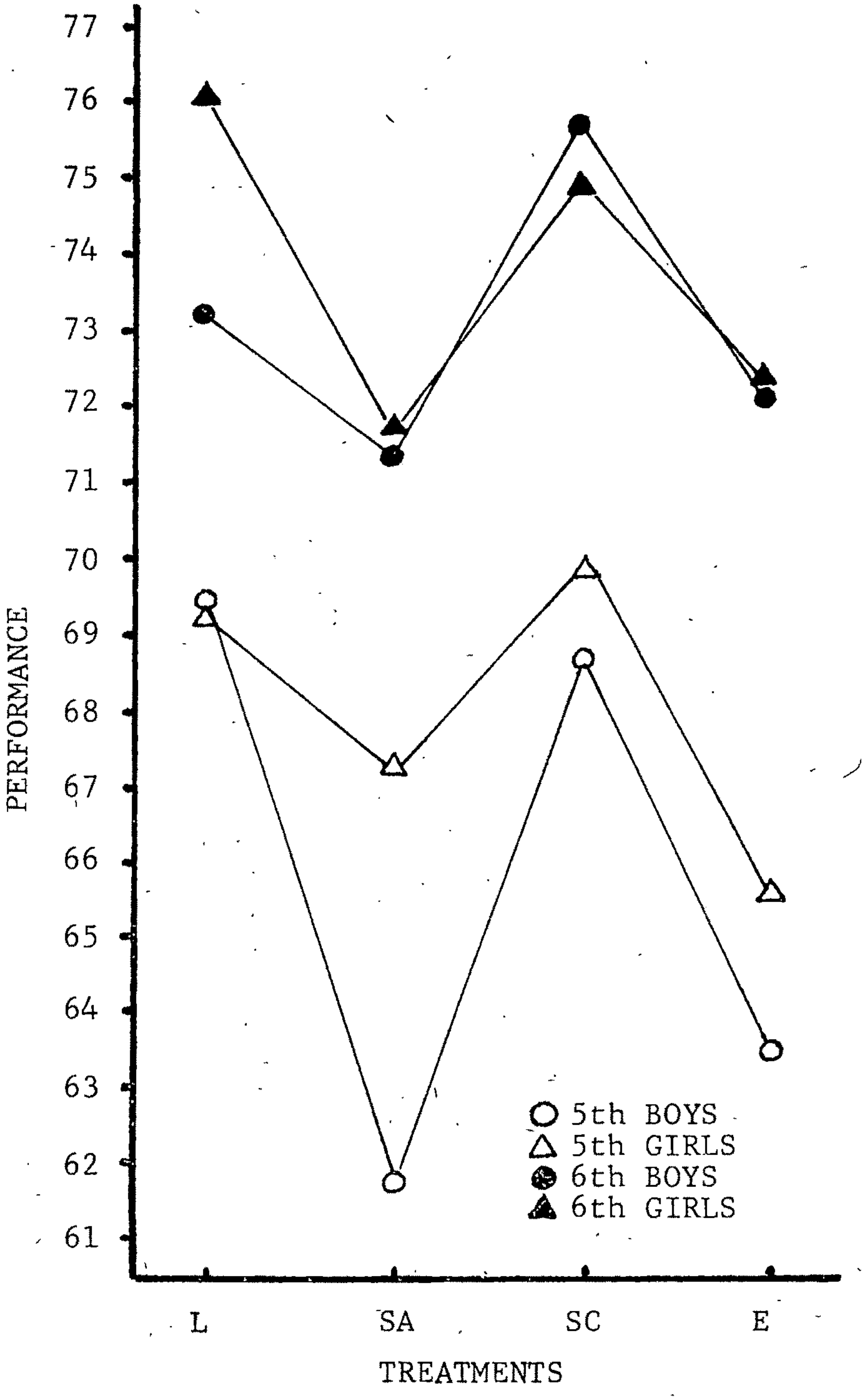
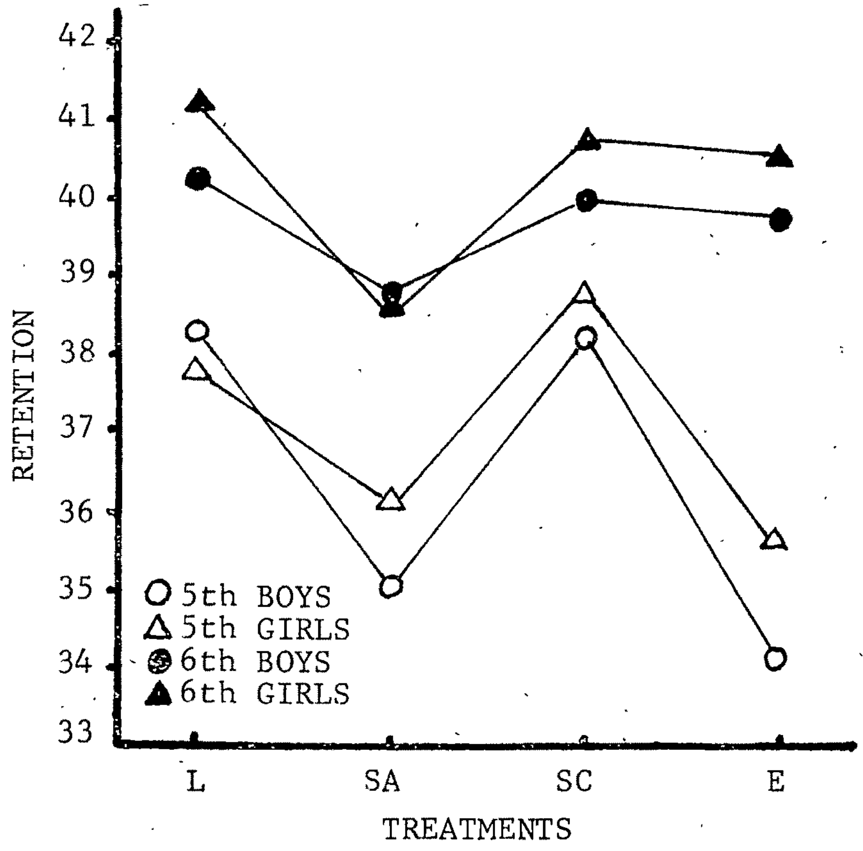


FIGURE 2

RETENTION AS A FUNCTION OF TREATMENT.



Correlational analyses indicated a positive relationship ($P < \cdot01$) between *Lk* and *P* in only two of the 16 cells; this supports the relatively weak relationship between academic performance and affective measures previously cited (Travers, 1967; Clifford, 1973; Clifford, 1975). *Lr* correlated with *P* ($P < \cdot05$) in 10 of the 16 cells, but with no pronounced pattern which favoured grade, sex or treatment. *AAA* correlated positively beyond the ·01 level with *P* in all but two of the 16 cells (i.e., fifth and sixth grade girls in the Error conditions). The relationships of these three variables with *R* reflected patterns similar to those cited for *P* above and suggest that locus of control is a more reliable predictor of achievement than is Perceived Learning which, in turn, is more reliable than Task Liking. All of these linear relationships confirm those reported in the option study (Clifford, 1975).

DISCUSSION

These data primarily indicate that the study materials used in this and the option study are a significant determinant of learning. Thus, there is a need, first, to re-evaluate and re-interpret the findings of the option study and secondly, to postulate factors accounting for the performance differences among the four study booklets.

As mentioned earlier the frequency with which booklets were assigned or selected in the option study was examined in relationship to students' IQ, obtained from school records. Mean IQ of students *assigned* to the List, Simple Association, Story Context and Error conditions were 114, 102, 109 and 110, respectively. The mean IQ of students *selecting* these booklets were 107, 104, 108 and 105 respectively. A Treatment × Booklet analysis of IQ yielded a main effect for Treatment ($P < \cdot 05$) and Booklet ($P < \cdot 001$) as well as an interaction ($P < \cdot 01$). In view of the means, one must first concede that IQ offers a partial explanation for the superior performance observed in the Teacher-Assignment condition. It will subsequently be argued, however, that there is yet another, and perhaps more potent factor, which accounts for these differences. One might also infer from the above mean scores that teachers perceived Simple Association as the easiest or perhaps most foolproof method of study and thus assigned it to low ability students. Similarly, it might be inferred that teachers judged List as the most difficult or challenging and thus assigned it to high ability students. IQ appears to be a far less prominent factor in the distribution of booklets in the Student-Selection condition.

A further examination of the distribution of booklets revealed that teachers assigned about 25 per cent of the students to each of the four types of booklets. On the other hand, more than 40 per cent of the students given an option selected Simple Association while only 14 per cent chose List, and the remainder were evenly divided between the other two forms. From this one might also infer that Simple Association was judged to be the easiest method of learning, and List either the most difficult or perhaps least interesting. Furthermore, given that each classroom was provided a limited number of each type booklet, such that no more than about 40 to 50 per cent of students in a given room could have any one type, the frequency with which students chose Simple Association may be a conservative measure of preference. In any event it seems reasonable to assume that both students and teachers judged Simple Association to be a more facilitative method of learning than List.

Given the findings of this more recent study, however, one must temporarily conclude that that condition assumed to be most facilitative of learning was one of the least facilitative methods, while that perceived to be perhaps least facilitative was in reality one of the most effective methods. Thus, one alternative explanation for the results of the option study lies in the differences between the proportions of students using the Simple Association and List booklets in each treatment. In other words, relatively few students in the Student Selection (as opposed to Teacher Assignment) condition were exposed to the more effective treatment, while a relatively large proportion were exposed to a less effective treatment.

The findings of the present study, examining booklet effectiveness, could possibly be a function of individual motivational or cognitive variables or a function of the materials *per se*. However, since there were no Treatment effects on either *Lk* or *Lr*, there is no available evidence on which to postulate a motivational explanation. On the basis of the descriptive statistics in Table 1, it could be argued that the superior performance of fifth grade males in List as opposed to Simple Association is a function of IQ; but a similar argument cannot be used to explain the observed difference for fifth grade females, or sixth grade males or females in these conditions. Furthermore, if IQ were a primary determinant of performance, then one would expect the latter three groups should have performed equally well in List and Error. This was not the case. A careful analysis of the Grade Equivalency scores (reflective of general cognitive achievement) provides a basis for a parallel argument and conclusion. At this point, therefore, it will be postulated that the observed differences in this study might better be accounted for in terms of variables other than those related to individual cognitive or motivational differences.

Reflection upon the materials and task *per se* suggests that an explanation may lie in the nature of transfer designs. It could be argued that while stimuli (words to be defined) were held constant across study list and test in all conditions, the degree of response similarity between study ' trials' and test ' trial ' differed markedly. Students in the Simple Association and Error were offered a specific initial response and subsequently had to produce a different response when given a test. This situation is representative of an A–B, A–C paradigm, typically associated with negative transfer.

On the other hand, students in List and Story Context conditions were given stimuli without responses. They had to seek an initial response for each stimulus. In so doing students might have been exposed to multiple responses (as would be found in a dictionary) or responses with relatively greater meaning (as might be obtained from a parent who defines a term and uses it in a sentence). If such were the case, the *probability* of response similarity between the learning and testing situation is likely to have been greater in List and Story Context conditions. Such an interpretation supports the principle that, if stimuli are held constant, the probability of positive transfer increases as response similarity or relatedness and/or response meaningfulness increases (Osgood, 1949; Bugelski and Cadwallader, 1956).

The practical implications of these two studies seem less than trivial. First, curricular materials judged on the basis of face validity (common sense), to be facilitative of learning were found to be more a liability than an asset. Secondly, teachers, who typically decide which materials a student will use, showed a tendency to assign relatively ineffective material to students of comparatively low ability. It seems reasonable to postulate, therefore, that slow learners are likely to be the most frequent victims of detrimentally simplified learning materials. Third, what were assumed to be non-substantial modifications in materials (booklet format) were found to have a significant effect on learning. This emphasises the need for and importance of critically evaluating the variety of available educational materials in light of fundamental principles of learning (e.g., transfer designs). Finally, at the risk of extrapolating too far, it is suggested that the value of work sheets and work-books consisting of fill-in-the-blank and matching exercises (which frequently accompany textbooks and are perceived by many publishers and teachers as a means to ensure learning) be assessed in terms of both verbatim learning and conceptual learning.

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THE RELATIONSHIP BETWEEN ACHIEVEMENT IN BIOLOGY AND COGNITIVE PREFERENCE STYLES IN HIGH SCHOOL STUDENTS

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SUMMARY. Tests of cognitive preference and achievement in high school biology were given to a stratified random sample of 989 Israeli twelfth grade students. Levels of cognitive preference and achievement were related to four independent variables namely sex, school environment, the nature of the curriculum and the attitudes of teachers toward an inquiry oriented curriculum. A strong dependence of cognitive preference orientation on achievement was found. High achieving students exhibited a strong preference for critical questioning, a weak preference for fundamental principles as well as a strong dissatisfaction with recall. The 'cognitive preference-achievement' relationship depended on the specific subject matter content, but was not related to Bloom's taxonomy levels. The 'cognitive preference-achievement' relationship was found to be significantly affected by sex, the school environment, the curriculum and the curricular bias of the teachers. Certain interactions among these independent variables were also revealed.

INTRODUCTION

COGNITIVE preference testing was introduced to curriculum evaluation as an attempt to measure *not* " whether the student can identify correct or incorrect information, but rather what he is likely to do with information intellectually " (Heath, 1964). As noticed by Harris, " most of the achievement testing in schools focuses on the 'can do' class of behaviours . . . these are the knowledge, skill, ability types of objectives. But there may be other objectives, the achievement of which is evidenced by what the student typically does do. These are the attitude, interest, cognitive style types of objectives—perhaps more affective than cognitive " (Harris, 1974, p. 86). Cognitive preferences belong to the second group, but occupy a middle position on a cognitive-affective continuum.

The following different modes in which the individual can attend to scientific information intellectually have been suggested by Heath:

(1) Acceptance of scientific information for its own sake, i.e., without consideration of its implication, application or limitations. This mode is designated as '*Recall*' (*R*).

(2) Acceptance of scientific information because it exemplifies or explains some fundamental scientific principle or relationship. This mode will be designated as '*Principles*' (*P*).

(3) Critical questioning of scientific information as regards its completeness, general validity or limitations. This mode is designated as '*Questioning*' (*Q*).

(4) Acceptance of scientific information in view of its usefulness and applicability in a general, social or scientific context. This mode is referred to as '*Application*' (*A*).

These modes have formed the blueprint for several cognitive preference tests, in which each item first presents some limited information or data of a scientific nature and then offers four extension statements, all correct, which correspond closely each to one of the four modes described above. Heath (1964) followed by Marks (1967), Atwood (1967 and 1971) and MacKay (1972) require that the student select out of the four extension statements the one that to him is the most satisfying or appealing and in so doing he is assumed to display his own cognitive preference. Kempa and Dube (1973) followed by Rogel (1974) have abandoned the response procedure just described in favour of a graded rating procedure in which the students are asked to arrange the options within each item in an order of preference by allotting four votes to the most preferred option, three votes to the next preferred, two to the next and one to the least preferred response. The advantage of this procedure is that all responses appearing in an item contribute to a student's overall cognitive preference profile, unlike the normal procedure of response selection where rejected options are treated as equally unattractive (Kempa and Dube, 1973, p. 281).

Kempa and Dube have been aware of the ipsative nature of the data obtained by the graded rating procedure. However, by employing proper statistical tests it was possible to conclude that the data obtained by graded rating are amenable to the usual normative statistical analyses without imposing undue bias (Kempa and Dube, 1973; Kempa, 1974).

All available cognitive preference tests with the exception of Atwood CPE-II (Atwood, 1971) have focused each on a particular science field. According to Atwood (1971), " the utility of these examinations is limited in that examinees must be familiar with an item's content to make a valid preference choice and only a relatively small portion of the subjects of interest to researchers in science education meet this criterion at any point in time." In response to this criticism Atwood constructed his CPE-II utilising general science and social science content. While cognitive preference tests such as CPE-II may be functional for certain purposes, their usefulness in assessing the outcomes of a specific curriculum is limited. It is the subject matter specificity of cognitive preference tests which appear to be a big advantage when compared with general tests such as Watson Glaser Critical Thinking Appraisal which provide no implications for specific educational treatments. This subject matter dependence is especially relevant when one deals with the relationship between cognitive preference and achievement which both relate to similar subject matter areas.

Many of the studies involving cognitive preference testing attempted to establish the relationship between achievement and cognitive preference styles with results which are summarised in Table 1.

TABLE 1

THE COGNITIVE PREFERENCE STYLES OF LOW AND HIGH ACHIEVERS.
(A SUMMARY OF RESEARCH FINDINGS).

Subject	Curriculum	*R*	*P*	*Q*	*A*	Reference
Physics	PSSC	—	+	+	—	Heath (1964)
Chemistry	CBA, traditional	NS	NS	NS	NS	Marks (1967)
Chemistry	CHEM Study	—	+	+	+	Atwood (1967b)
Chemistry	Nuffield	—	+	+	—	Kempa and Dube (1973)
Chemistry	CHEM Study	+	+	+	NS	Rogel (1974)
	traditional	NS	+	NS	—	Rogel (1974)
Biology	BSCS, traditional	—	NT	NS	+	Barnett (1974)

+ higher score to high achievers; — higher score to low achievers;
NS non-significant difference between high and low achievers; NT not tested.

From Table 1 may be seen that in all the studies low achievers in the ' new ' programmes of study display a higher preference for *R* while high achievers display a higher preference for *Q* and *P*. With traditional or mixed samples, there are no clear-cut trends.

The purpose of the present study is to investigate:

(1) The relationship between achievement and cognitive preference styles in high school biology.

(2) The cognitive preference-achievement as manifested by different biological topics as well as by different Bloom's taxonomy levels.

(3) The effects of four independent variables (as well as their interactions) on this relationship. These variables are: sex of students, type of school, the curriculum studied and the curricular bias of the teachers. These four variables were selected because of their previous history as potential contributors to learning outcomes generally and to cognitive preferences particularly (i.e., Tamir, 1975a; Tamir, 1975b).

TESTS

Tests.

The construct validity of cognitive preference tests has been established by numerous researchers (Heath, 1964; Marks, 1967; Atwood, 1967; Kempa and Dube, 1973). The cognitive preference test used in the present study has been validated by the procedures advocated and employed by former researchers (see below). The Biological Cognitive Preference Test (BCPT) was designed in Israel following an analysis of the subject matter content of the current three biology matriculation syllabuses. This procedure has ensured that all information incorporated in the test fell within the cognitive framework of the twelfth grade students participating in the study. In its operational form BCPT comprised 40 items. A typical item is shown below, together with the cognitive preference implied by each response.

Penicillin was discovered by Alexander Fleming in 1928.

(*a*) Penicillin is extensively used by doctors in the treatment of bacterial diseases (*A*).

(*b*) Penicillin is an antibiotic drug (*R*).

(*c*) Penicillin, like other antibiotics, is produced by a living micro-organism and is effective in the control of micro-organisms (*P*).

(*d*) Penicillin is not an effective treatment for all bacterial diseases and a whole range of other compounds has been developed to treat bacterial diseases (*Q*).

The key (allocation of each option to one of the four cognitive preference areas) was determined by expert judges and only items reaching at least 90 per cent agreement were included.

The graded rating procedure suggested by Kempa and Dube (1973) was employed. Thus, for each cognitive preference area the highest possible score is 160 and the lowest is 40. A complete response yields a total score of 400. A random response distribution should yield a mean score of 100 for each of the cognitive preference areas.

The Biological Achievement Test (*BAT*) is a 30-item multiple choice test covering major biological topics such as botany, zoology, human biology, heredity and statistics. Special care was taken to ensure that the test had no instructional bias in favour of any of the three matriculation syllabuses followed by the subjects in the sample. The test has a KR-20 reliability of 0·79 obtained with this sample (see Tamir, 1975a).

Sample and Procedure.

The subjects (N=989) were a stratified random sample of Israeli twelfth grade students (out of a total population of approximately 3,000) representing city, agricultural and kibbutz high schools, who sat for the matriculation examination in biology in the year 1973. 408 of the subjects studied the Israeli BSCS Adaptation programme for four years (they are designated as BSCS) and the other 581 studied traditional biology (they are designated as Non-BSCS). All the teachers (N=50), who administered the tests in May, 1973, responded to the Blankenship Attitude Inventory (Blankenship, 1966) and were classified on the basis of their score into two groups. The first group (N=24) included all teachers whose score on the Blankenship inventory was above the national mean of 30·70 (Tamir, 1974) and may thus be taken to be in favour of new instructional programmes. They are designated as BSCS *supporters*. The other group (N=26)—non-supporters—comprised teachers who scored below the national mean.

RESULTS AND DISCUSSION

Analyses were performed to investigate the various problem areas identified in the Introduction. First, there was the comparison of achievement with cognitive preference. On the basis of their achievement scores (BAT), four sub-groups were formed so as to divide the sample equally, as far as possible. The highest achievers were in *Group* 4, while those with the lowest scores were in *Group* 1. Means and standard deviations for the whole sample and each sub-group are shown in Table 2.

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR COGNITIVE PREFERENCE SCORES.

Cognitive Preference Area	Total (N=989)		Achievement Category							
			High (4) (N=263)		(3) (N=232)		(2) (N=256)		Low (1) (N=238)	
	M	SD	M	SD	M	SD	M	SD	M	SD
Recall (R)	97·2	16·7	93·6	17·4	94·5	17·6	98·5	16·4	102·4	14·2
Principles (P)	112·2	14·3	112·8	14·5	112·8	15·3	112·3	13·1	109·8	13·8
Questioning (Q)	95·8	18·3	99·6	19·7	98·2	18·2	94·4	17·1	90·7	16·8
Application (A)	95·0	12·3	93·6	12·4	94·5	12·9	94·9	11·4	96·8	12·6

Considering the data obtained for the whole population, it is seen that the mean score for *P* is much higher than that of the other three cognitive preference areas, which are very close to each other. It may be concluded that either the test is biased in favour of *P* or that the Israeli high school students have a bias for *P*. The results obtained by Rogel (1974) with similar Israeli high school students lend support to the second conclusion. While Kempa and Dube (1973) obtained a *P* mean score of 103·4 with their English sample, Rogel obtained a *P* mean score of 115·9 for his Israeli sample, both using the same chemistry cognitive preference test. This mean score of 115·9 is even higher than the *P* mean score of 112·2 obtained in the present study.

Table 3 presents the results of one-way analysis of variance on the data in Table 2. Comparison of the mean scores of students in different achievement categories reveals a strong dependence of cognitive preference orientation on academic achievement. High achieving students exhibit a strong preference for *Q*, a weak preference for *P*, and a strong dissatisfaction with *R*. Area *A* does not discriminate between high and low achievers.

TABLE 3

ONE-WAY ANALYSIS OF VARIANCE AND T-TESTS ON COGNITIVE PREFERENCE SCORES OF DIFFERENT ACHIEVEMENT GROUPS SHOWN IN TABLE 2.

Cognitive Preference Area	F	Value of t Comparing Sub-Groups Shown					
	df=3,986	1:2	1:3	1:4	2:3	2:4	3:4
Recall (R)......	13·2†	2·1*	5·0†	5·5†	2·9*	3·3†	0·3
Principles (P) ..	3·3*	2·7*	2·3*	2·8*	0·1	0·3	0·3
Questioning (Q)	13·4†	2·9*	4·8†	5·9†	2·0*	3·2†	1·1
Application (A)	1·7		non-significant				

* P<0·05 † P<0·01

Since Barnett's (1974) study is the only study dealing with biology students and at the same time reporting a positive correlation between A and achievement, it was decided to follow his analysis here. The students were thus classified on the basis of their score on the cognitive preference test into three groups as follows:

(*a*) High *R*—subjects scoring >114 (more than 1 SD) in *R*.
(*b*) High *A*—subjects scoring >107 (more than 1 SD) in *A*.
(*c*) High *Q*—subjects scoring >114 (more than 1 SD) in *Q*.

Table 4 presents a comparison of the achievement of the groups thus obtained.

TABLE 4

ACHIEVEMENT IN BIOLOGY OF STUDENTS WITH DIRECT COGNITIVE PREFERENCE STYLES.

Area of Knowledge or Skill	High *R* (1) (N=140)		High *A* (2) (N=98)		High *Q* (3) (N=110)		F DF= 2,345	t Tests between Sub-groups		
	M	SD	M	SD	M	SD		1:2	1:3	2:3
Human biology	1·9	1·0	1·9	1·0	2·2	1·0	2·9*	0·7	1·7	2·3*
Botany	4·4	1·8	4·5	2·0	5·5	1·7	13·2†	0·4	5·1†	4·0†
Zoology	4·1	1·8	4·2	1·7	4·8	1·7	4·7†	0·1	2·8†	2·5*
Heredity	1·9	1·4	2·1	1·4	2·4	1·4	4·2*	0·7	2·9†	1·9
Statistics	0·4	0·7	0·3	0·6	0·4	0·6	0·5	non-significant		
Other topics	1·4	0·8	1·4	0·8	1·6	0·8	2·2	non-significant		
Knowledge	4·8	1·9	4·7	1·7	5·6	1·7	9·6†	0·5	3·7†	4·1†
Comprehension	5·3	2·2	5·5	1·9	6·1	1·9	5·5†	0·6	3·2†	2·5*
Higher abilities..	4·1	2·1	4·3	2·1	5·2	1·9	9·4†	0·5	4·2†	3·3†
Total Test	14·2	5·0	14·4	4·7	16·9	4·4	11·9†	0·3	4·6†	4·0†

* P<·05 † P<·01

Neither in the total test, nor in any topic is there any result in favour of High *A*. On the other hand, students with High *Q* achieved significantly better than the other two groups in most areas. The fact that in two areas there were no significant differences hints at one possible explanation for the discrepancy between Barnett's results and ours. Barnett used CPE-II which utilises general science and social science content (Atwood, 1971). It has been shown elsewhere (Tamir, 1975b) that there exists a strong dependence of cognitive preference on the subject matter area. Perhaps, the difference in the contents of CPE-II and BCPT accounts for the differences in the results obtained in the two studies.

Achievement, cognitive preference and subject matter specificity.

We are dealing with cognitive preference in biology and yet biology itself may be divided into different subject matter areas. A special analysis was undertaken to find whether specific subject matter areas exert specific effects on the relationship between cognitive preference and achievement. Three areas, namely botany, zoology and human biology, were identified. The items which deal with each of these topics comprised three cognitive preference subtests and three achievement subtests. Two kinds of analyses were undertaken. First, intercorrelations among cognitive preference scores and achievement in each of the three topics were calculated. Second, the cognitive preference scores of low and high achievers in each of these three topics were compared by analysis of variance. Only a summary of the results can be reported here. In all topics achievement was found to be positively correlated with *Q* and negatively correlated with *R*. On the other hand, while achievement in botany and zoology was positively correlated with *P*, that in human biology was positively correlated with *A*.

The analysis of variance revealed that:

(1) Low achievers in botany preferred *A* more than high achievers especially when they dealt with information of botanical nature.

(2) Unlike in other topics, the different achievement groups in zoology did not differ in their degree of preference for *R*.

(3) Regardless of achievement level, human biology *A* score was distinctly high. High achievers in human biology had a higher preference for *P* as far as general biology was concerned, but not so regarding human biology.

It may be concluded that the relationship between cognitive preference and achievement depends, to some extent, on the subject matter content of the cognitive preference tests employed.

Cognitive abilities and cognitive preferences.

It might have been hypothesised that a higher preference for *Q* will be related to a higher achievement in tasks which call for higher cognitive abilities. BAT was categorised into three subtests according to Bloom's taxonomy. The correlations between the four cognitive preference scores and the achievement in each of the three subtests, as well as in the total test, were calculated. The correlation coefficients ranged between −0·06 and 0·17. Similar results were obtained by Rogel (1974). It may be concluded that cognitive preferences are *not* related to the cognitive ability levels of Bloom's taxonomy.

Sex.

Table 5 compares the results obtained by males and females Both males and females with high achievement scores have a high preference for *Q*, but only among the boys did high achievers show a greater preference for *P*. Among the girls low achievers show a greater preference for *R* than do high achievers. Among students with high achievement scores, males tend to prefer *R* more than females. Finally, girls with low levels of achievement show a greater preference for *R* than do low achieving boys, who tend to opt for *Q*.

TABLE 5

COGNITIVE PREFERENCES OF MALES AND FEMALES HIGH (HI) AND LOW (LO) ACHIEVERS.

		Cognitive Preference Area							
		Recall		Principles		Questioning		Application	
Groups		M	SD	M	SD	M	SD	M	SD
1 Males	HI(N=133)	96·5	16·1	112·9	12·6	100·3	16·9	94·8	11·3
2	LO(N=100)	100·4	15·5	107·2	13·8	93·7	18·2	96·4	12·9
3 Females	HI(N=130)	91·5	18·3	113·6	16·3	99·8	22·2	93·3	13·4
4	LO(N=138)	103·3	13·1	111·5	13·6	88·1	15·3	96·4	12·5
F (df=3,497)		13·6†		4·5†		13·3†		1·7	
t	1 : 2	1·9		3·2†		2·8†		NS	
	3 : 4	6·0†		1·2		5·0†		NS	
	1 : 3	2·3*		0·4		0·2		NS	
	2 : 4	1·6		2·4*		2·5*		NS	
F interaction 3·4† df=(1,497)		7·7†		1·9		2·4		0·4	

* P<0·05 †P<0·01

Type of school.

A comparison of students in the three different types of schools revealed no significant differences between groups of high and low achievers in city schools, while in agricultural and kibbutz schools a high-low difference appeared in *Q*.

The *low* achievers may be characterised as follows:

In agricultural schools: high *R*, high *A*, low *Q*, low *P*.
In kibbutz schools: high *R*, high *A*, low *Q*.
In city schools: low *A* with a tendency to be low *Q*, high *R*.

A three-way analysis of variance revealed significant interactions between sex, type of school, cognitive preference and achievement regarding *A*. For example, the mean *A* score of low achieving girls in kibbutz schools is 16 points higher than that of the low achieving girls in city schools while the difference between the *A* scores of the boys is less than 1 point. And as another example, while the *R* difference between high and low achievers in agricultural schools is only 0·4 points, in the kibbutz schools it is 7 points and between high achieving females and low achieving males in the kibbutz it reaches 19·4 points!

Nature of the curriculum.

Table 6 compares the results of BSCS and non-BSCS students. It may be seen that the high-low achievement differences are greater for the non-BSCS students than for the BSCS. The non-BSCS low achievers were extremely high in *R* and low in *Q*. One possible interpretation is that an inquiry oriented curriculum, such as the BSCS, may promote relatively high positive *Q* and negative *R* preferences even among low achievers. A BSCS student with low achievement may be characterised as high *R*, while one with high achievement has very low *R*, high *Q*. A non-BSCS student with low achievement may be characterised as very high *R*, low *P*, very low *Q*, while a high achiever in the non-BSCS group has low *R*, high *Q*, high *A*.

TABLE 6

COGNITIVE PREFERENCES OF BSCS AND NON-BSCS HIGH (HI) AND LOW (LO) ACHIEVERS.

Groups		Cognitive Preference Area							
		Recall		Principles		Questioning		Application	
		M	SD	M	SD	M	SD	M	SD
1 BSCS	HI(N=156)	93·2	18·3	113·5	16·1	99·8	21·1	93·9	13·3
2	LO(N=52)	98·8	15·6	110·0	11·3	96·5	17·1	94·4	11·0
3 Non BSCS	HI(N=107)	95·2	15·9	112·9	12·0	100·5	11·6	98·1	10·0
4	LO(N=186)	103·0	13·7	109·6	14·5	88·8	16·4	95·9	13·3
F (DF=3,497)		12·0†		2·7*		13·9†		1·9‡	
t	1:2	2·2*		1·7		1·1		NS	
	3:4	4·2†		2·1*		5·6†		NS	
	1:3	1·0		0·4		0·3		2·4*	
	2:4	1·8		0·2		2·9†		NS	
F interaction=1·3 (DF=1,497)		NS		NS		NS		NS	

* P< ·005.   * P<0·01   NS—Non-significant.

‡ The F is statistically significant only at 0·1 level, but it was decided to draw attention to the t-value between groups 1 and 3.

TABLE 7

COGNITIVE PREFERENCES OF HIGH (HI) AND LOW (LO) ACHIEVING STUDENTS TAUGHT BY SUPPORTERS AND NON-SUPPORTERS OF BSCS.

Groups		Cognitive Preference Area							
		Recall		Principles		Questioning		Application	
		M	SD	M	SD	M	SD	M	SD
1 Supporters	HI(N=119)	91·1	16·3	114·9	14·9	101·1	20·5	96·0	11·3
2	LO(N=79)	100·1	14·6	106·7	13·6	94·6	16·9	97·5	11·7
3 Non-supporters	HI(N=144)	96·4	17·9	111·9	14·3	99·2	19·0	92·5	13·0
4	LO(N=159)	103·0	14·0	111·2	13·8	88·4	16·4	95·8	13·1
F (DF=3,497)		13·8†		5·4‡		13·7†		3·4*	
t	1:2	4·1†		4·0†		2·4*		0·9	
	3:4	3·6†		0·5		5·3†		2·2*	
	1:3	2·5*		1·7		0·8		2·3*	
	2:4	1·5		2·3*		2·7†		1·0	
F interaction=4·5† (DF=1,497)		0·7		8·0†		1·6		0·6	

* P< ·05   † P<0·01

The curricular bias of the teachers.

Table 7 compares the results of students being taught by BSCS supporters and those by non-supporting teachers. In summary:

Achievement of student	*Attitude of teacher*	*Cognitive preference style*
Low	supporter	high *R*, low *Q*, low *P*.
High	supporter	very low *R*, high *Q*, high *P*.
Low	non-supporter	very high *R*, very low *Q*.
High	non-supporter	low *R*, low *A*.

A three-way analysis of variance revealed significant interactions between the nature of the curriculum, the curricular bias of the teachers, cognitive preferences and achievement. The characteristics of the different groups are summarised in Table 8. Again a three-way analysis of variance revealed no significant interactions either among achievement, sex and the nature of the curriculum or among achievement, sex and the teacher's curricular bias.

TABLE 8

SUMMARY OF THE CHARACTERISTICS OF THE DIFFERENT GROUPS.

Student Groups		Cognitive Preference Area				
Course	Teacher Attitude	Achiev.	Recall	Principles	Questioning	Application
BSCS	Supporters	HI	−	+	+	+−
		LO	−	−	+	+
	Non-supporters	HI	−	−	+	−
		LO	++	+−	−	+−
Non-BSCS	Supporters	HI	−−	+−	++	+
		LO	++	−−	−	+−
	Non-supporters	HI	+−	+	+	−
		LO	++	+−	−−	+−

Key: −− very low; − low; +− average; + high; ++ very high.

CONCLUSIONS

(1) The strong dependence of cognitive preference orientation on academic achievement has been confirmed with regard to high school biology students. High achieving students exhibit a strong preference for *Q*, a weak preference for *P* and a strong dissatisfaction with *R*. For some students high achievement is also related to their preference for *A*. However, the direction of this relationship differs. For example, *low* achievers who study a BSCS course from BSCS supporting teachers have a high preference for *A* just like ***high*** achievers who study a non-BSCS course from teachers who do not support the BSCS approach.

(2) The 'cognitive preference-achievement' relationship depends on the subject matter content of the cognitive preference tests employed. The same student may display different 'cognitive preference-achievement' relationships regarding different topics.

(3) Cognitive preference styles were found to be unrelated to Bloom's taxonomy levels.

(4) Females and males differ in their 'cognitive preference-achievement' relationship. These differences imply that results obtained with boys (i.e. Kempa and Dube, 1973) may not be applicable to girls, and *vice versa.*

(5) The school environment has remarkable effects on the interaction between cognitive preferences and achievement and these effects regarding boys are different from those regarding girls.

(6) Much higher differences between HI and LO exist for non-BSCS students. It appears as if an inquiry-oriented curriculum such as the BSCS may promote curiosity even on the part of low achieving students. Our results may now be added to those presented in Table 1 as follows:

Subject	*Curriculum*	*Recall*	*Principles*	*Questioning*	*Application*
Biology	BSCS	–	+	+	NS
Biology	Traditional	–	+	+	+ (NS)

Thus, a high preference for *A* tends to be associated with high achievement under a traditional curriculum, a result which partially confirms Barnett's (1974) findings.

(7) The curricular bias of the teachers appears to have a strong effect on the 'cognitive preference-achievement' complex. Regardless of the curriculum studied high achieving students of high supporting teachers are very low *R*, high *Q*, high *P*, while high achievers non-supporters are low *R*, low *A*. When the curriculum studied enters into the picture, certain trends become very explicit. Thus, the highest *R* preference score belongs to low achieving BSCS non-supporters, while the lowest *R* preference score belongs to high achieving BSCS supporters. It appears that regarding *R* the teachers' bias, rather than the nature of the curriculum, is the dominant factor. For *A*, however, the dominant factor appears to be the nature of the curriculum, while a combined effect of the two factors is apparent for *Q* where the lowest score belongs to non-BSCS non-supporters.

(8) The present study shows that the cognitive preference achievement relationship is not unidimensional. Rather, it depends on a combination of personal, environmental, subject matter and instructional variables. The question of whether cognitive preference style affects or is affected by achievement, or perhaps both processes take place simultaneously, remains open.

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DIMENSIONS OF STUDY BEHAVIOUR: ANOTHER LOOK AT ATI

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SUMMARY. This paper reports a series of studies in the development of a Study Behaviour Questionnaire (SBQ), for use with university students. The major problem in the present research was to determine optimal ways of combining SBQ item scores: by sorting people's responses to items (R-analysis), or by sorting items on the basis of how they discriminate between people (Q-analysis).

464 Arts and Science first-year students completed the SBQ. The responses were analysed in both R and Q designs, and the resulting scale scores for each student were merged with his high school and university performance data. In the R-analysis, 102 items were selected to sample 10 domains of study behaviour, and responses to these items were subjected to an oblique multiple group method of factor analysis. The 10 domains of study behaviour were confirmed although there was some significant intercorrelation between domains. In the Q-analysis, four students were chosen at random from the Ability (high, medium, low) × Faculty (Arts, Science) × Sex matrix, replicated once. These categories were called ' tests,' and the items ' people.' Using an oblique Procrustes method of factoring, three Q-scales were obtained. Factor scores on each of the 10 R and three Q scales were obtained for each student, and relationships with sex, faculty and performance were investigated.

INTRODUCTION

RECENT research into students' study behaviour reflects a similar shift to that obtaining in instructional research generally, that is, a movement away from *main effects* to *interactive* models of the instructional process. Educational researchers have become increasingly dissatisfied with the apparently logical Pre-test—Treatment A/Treatment B—Post-test design in methods research, because it has produced equivocal or non-replicable results. Cronbach (1967) sounded the death knell to this main effects model and proposed instead the model employing *aptitude-treatment interaction* (ATI).

The ATI model is based on the apparently reasonable assumption that if two treatments (methods) are indeed different (e.g., in the processes of learning demanded of students) then the almost universal conclusion of " no differences between treatment groups " does not necessarily follow if no attempts have been made to find out whether *particular* sub-groups of students have indeed been differentially affected. Certainly both psychological theory, as well as the intuitions of teachers, would predict such differential effects. A group of characteristics discriminating the high and low performers in the two treatments Cronbach calls an *aptitude*. This is defined as " whatever promotes the pupil's survival in a particular educational environment," and an aptitude in this sense may as well be a personality as an intellectual variable. Differential treatment is most desirable when a cross-over or disordinal interaction occurs, when main effects are zero.

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Cronbach's formalisation of ATI sparked a renewal of interest in the whole question of teaching method and individual differences, but the results were disappointing. Currently, opinion seems to be hardening against the ATI approach. Two examples will illustrate this.

Bracht (1970) reported a review of existing studies that seemed to suit Cronbach's requirements for ATI. Of 108 studies, 103 showed no interaction or ordinal interaction: only five gave significant evidence of disordinal interaction. This number is that which would be expected on the basis of chance.

Goldberg (1969) administered batteries of personality and cognitive style tests to 900 students and was able, by using subscales and total scores on dozens of tests to categorise his sample into 350 different ' aptitudes.' Students were then allocated into one or other of two treatments: a highly formal lecture method, and a loosely structured independent study method. He then substituted each of the 350 aptitudes in turn in the Aptitude × Treatment design. As in Bracht's study, the number of acceptable ATIs that emerged was that expected by chance.

It seems, however, that much of the recent work on ATI has missed what was, after all, Cronbach's most important point: namely, each treatment will call out different personological characteristics. In other words, effective survival in a given environment might require a fairly unique mix of characteristics which would add up to a multidimensional ' stance ' towards that particular environment, rather than a unidimensional personality trait that remains stable across several environments. The word ' aptitude ' itself has the connotation of a single trait-like characteristic (and it is true that Cronbach himself urged that one investigate ' structurally simple ' aptitudes) but the evidence seems quite clear that unidimensional aptitudes, derived from consistency across people, is not working too well. The alternative is to look at aptitudes that are consistent within the situations one is interested in, whether or not they are consistent across the people involved in these *and other* situations.

Look at what Goldberg did. He took 350 scale and subscale scores (e.g., the CPI, 16PF, etc.) that previous research had shown to be unidimensional: they had nothing to do *a priori* with the treatments to which his subjects were exposed. It is not surprising, then, that he obtained virtually chance results. Less obviously Bracht surveyed studies that *post hoc* happened to fit the requirements of the ATI model : in few, if any, of the studies reviewed were the personological characteristics of the students (and the ways in which they were grouped) determined by the nature of the *treatments*.

The most recent work of Hunt (in Hunt and Sullivan, 1974) seems to fit the notion of genuine interaction between person characteristics and treatment rather more appropriately than the work referred to above. He presented a ' cafeteria ' of environments and let the student choose the environment in which he felt most comfortable. In a high school in suburban Toronto, incoming Grade 9 students could attend classes, during an orientation week, representing different teaching styles, differing along a continuum of structure. At the high structure extreme, the environment was strongly teacher-directed, didactic, and involving minimum student decision-making. At the low structure extreme, the initiative for choosing tasks and resources for tackling them was left to the student. Students then continued for that year in the teaching environment of their choice, with the proviso that those who initially chose high structure environments were encouraged to progress via intermediate structure, to low structure, environments.

Here the problem of the aptitude is solved very neatly; to say nothing of the ' ecological validity ' (Bracht and Glass, 1968) of using the natural environment of the school as point of departure. The aptitude (Conceptual Level; Hunt, 1971) becomes a hypothetical construct; it is conceptually valuable for construing the environment and the learner's place in it, but need not actually be measured or even defined, in terms other than ' environment fit.' In the traditional approach to ATI, on the other hand, the dimensions of the *person* are taken as given so that fit to the environment is more or less coincidental, as the record shows (see also Snow, 1974). In Hunt's model, dimensions of the *environment* are fitted to the person. Since educators are mainly concerned with creating and maintaining environments, it would seem more logical to attempt to find ATI by starting with the environmental constraints first.

RESEARCH IN STUDY BEHAVIOUR

The present study is an attempt to apply this ' environmental ' interpretation of ATI to the area of student study behaviour and faculty performance. As with the main effect work on teaching method, the days of researching into the ' one best method ' of studying (e.g., SQ3R) have gone. Even if the ATI model has not been specifically referred to, recent research has looked for interaction, e.g., the relative effectiveness of different approaches to study in Arts or Science (Biggs, 1970a; Goldman and Warren, 1973), under objective or essay formats of evaluation (Biggs, 1973) or under different models for combining marks for final evaluation (Biggs and Braun, 1972).

Here, we are concerned with the question of faculty differences in study behaviour. Does success in Arts require a different approach to study than success in Science? Are there study strategies that are useful whatever the field of study? Some research has been conducted on personality and attitude differences between faculties, but there has been surprisingly little research involving study behaviour *per se.* Biggs (1970a) found that success in Arts was related to two rather different types of strategies: (i) reproductive, where the student gives back prescribed material intact; and (ii) transformational, where the student ranges widely over material and injects his own meaning and interpretations. Success in Science was unrelated to either strategy: the most important predictor here was prior mastery in the content area concerned.

Goldman and Warren (1973) found that while students in different subject areas could be discriminated in terms of ' pure ' *versus* ' applied ' interests, no differences between high and low performers in different faculties could be found with respect to study behaviours *per se.* Two approaches to study, ' diligence ' and ' cognitive activity ' (the latter corresponds to Biggs's transformational strategy) discriminated between good and poor performers but irrespective of their faculty orientation.

If one regards performance within a faculty as analogous to a ' treatment,' then the state of play in this area strongly recalls that prevailing in ATI in general: the theory is willing but the evidence is weak.

The second line of research in the tertiary area has been to link study behaviours with personality factors. First, unidimensional study strategies or attitudes are isolated, e.g., spotting and rote learning detail or consciously relating new material to known material. Second, usage of such strategies is correlated with personological characteristics. Where such correlations are significant, it is presumed that the personality characteristics (e.g., divergence, intolerance of ambiguity, cognitive complexity, etc.) in some sense determine or preset the individual to study in a certain way (Biggs, 1970b; Entwistle and

Entwistle, 1970). Biggs and Das (1973) found that individuals who were ' internalisers ' (endorsed extreme categories on self-related items) were introverted, divergent, and tended to use transformational study strategies, while ' externalisers ' (endorsed extreme categories on items relating to others) were extraverted, dogmatic and used reproductive study strategies : both internalisers and externalisers achieved identical grades (in Educational Psychology). This relationship between personality and learning style would seem to be rather more fruitful for ATI work in the tertiary area, because the aptitude becomes definable in terms of learning style and this is evidently more closely related to teaching style (' treatment ') than aptitude defined in terms of personality alone.

This approach is, however, as committed to the 'transituational fallacy' as is the earlier work on ATI; in both cases the ' aptitude ' is presumed to operate consistently across situations. In the Biggs studies, for example, the dimensions of study behaviour were deliberately unidimensionalised: the scales so derived emerged *precisely because* there was high agreement amongst respondents from a variety of backgrounds that certain types of item ' go together.' As argued above, however, such procedures would minimise the chances of finding ATI.

The alternative is to follow Hunt's lead and, as it were, let the particular environments sort the specific attributes that may be relevant to functioning in one environment as opposed to another. Hunt did this by letting each student decide for himself whether he was a ' high structure type ' or a ' low structure type.' There are, however, other ways of doing this: the problem would appear to relate closely to the distinction Cattell (1966) draws between R-analysis and Q-analysis. In R-analysis, people are pooled and consistencies between responses are sought: this is the approach in traditional factor analysis and in the internal consistency approach to scaling as exemplified in the KR-20 and Cronbach's alpha. In Q-analysis, on the other hand, responses and people are transposed : instead of finding out how responses cluster together and form scales, the interest here is in finding out whether people cluster together and form groups that fit treatment characteristics.

In the present investigation, R and Q approaches to clustering study behaviour are contrasted with reference to their amenability to the general ATI model.

METHOD

The R-scales.

This study was originally conceived in an R-analysis framework. The general aim was to develop a Study Behaviour Questionnaire (SBQ) containing unidimensional subscales, each of which had been shown to relate on the one hand to stable personality characteristics of the student, and on the other to task characteristics, e.g., field of study, method of evaluating learning, level of learning, and so on.

In the present study, 10 dimensions of study behaviour were taken as the point of departure. Roughly 10 items per dimension were selected as ' prescribing ' that dimension: mostly these were items that had been established in previous studies (Biggs, 1970a, 1973). There were 102 items in all, in a Likert format, and they were administered to 464 Arts and Science entering students enrolled in a first year course in English and in Chemistry. Their responses were used for the *R-analysis,* the purpose of which was to obtain maximally consistent versions of the postulated scales. While each scale had been established both logically and empirically as an independent construct, it seemed unduly restrictive to insist that they should be orthogonal.

The method of factor analysis chosen for the R-analysis was the oblique multiple group method (Harman, 1960), which involves obtaining the first principal component of each of the 10 sets of prescribed items and then calculating component scores for each person on each subscale. The correlations between each component score and each item gave a 10 × 102 matrix, which was the basis for obtaining the oblique factor pattern, adjusted for the correlation between components. A final loading of + ·30 or more was taken as confirming that a particular item should be included in a subscale. This resulted in a loss of 22 items; all remaining items were amongst those originally prescribed as defining a scale, and no remaining items were non-prescribed. This gives strong support for the reliability and validity of the original scales.

A brief description* of scales follows:

*R*1: *Academic aspiration* ($\alpha = \cdot 745$: 10 items)
Pragmatic, grade-oriented, university as means.
*R*2: *Academic interest* ($\alpha = \cdot 729$; 10 items)
Intrinsically motivated, study as end.
*R*3: *Academic neuroticism* ($\alpha = \cdot 643$; 7 items)
Confused, overwhelmed by demands of course work.
*R*4: *Internality* ($\alpha = \cdot 548$; 8 items)
Sees ' truth ' coming from within not external authority.
*R*5: *Study skills and organisation* ($\alpha = \cdot 580$; 8 items).
Works consistently, reviews regularly, schedules work.
*R*6: *Fact-rote strategy* ($\alpha = \cdot 588$; 8 items)
Centres on facts, details, rote learns.
*R*7: *Dependence* ($\alpha = \cdot 466$; 6 items)
Rarely questions instructors, tests; needs support.
*R*8: *Meaning assimilation* ($\alpha = \cdot 709$; 8 items)
Reads widely, relates to known, meaning oriented.
*R*9: *Test anxiety* ($\alpha = \cdot 791$; 6 items)
Very concerned about tests, exams, fear of failure.
*R*10: *Openness* ($\alpha = \cdot 440$; 9 items)
University place where values are questioned.

In computing an individual's scale scores, however, factor loadings were ignored: all items responses were given equal weight and each response was simply added up within each scale.

The Q-scales.

In the Q-analysis, the question is to see if it is possible to characterise ' Science types ' and 'Arts types ' in terms of their different study behaviours; it is also possible that sex differences exist in these characterisations.

A 2×2×3 matrix of Sex (M, F) × Faculty (Arts, Science) × Performance (High, Medium, Low GPA) was set up and eight students from each cell were randomly selected and grouped into two lots of four students per cell, giving 24 cells in all. The means of each cell for each of the 80 items surviving from the R-analysis was then calculated : this gave a 24 × 80 (person-group × items) response matrix. This was then transposed into an items × group matrix, and the 24×24 correlation matrix for groups across items was calculated and subjected to a principal components analysis. Three factors with eigen values greater than unity were obtained and these were rotated to a varimax solution, which became the input to an oblique Procrustes factor analysis. In the latter,

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*** A full listing of the items and factor loadings may be obtained from the author.**

an ideal target factor pattern is set up, and the real data are manipulated to see if they can match this target.

In the present investigation, two targets were set up (see Table 1). In the first, it was hypothesised that three patterns of study behaviour were distinguishable: (i) a general achievement factor, independent of both sex and faculty; (ii) a pattern specific to Arts; and (iii) a pattern specific to Science. In the second, essentially two patterns were hypothesised: (i) Arts ability, and (ii) Science ability. (The third factor was a nonsense factor selected so that the variance of the middle groups would be used).

TABLE 1

Q-ANALYSIS: VARIMAX INPUT, TWO PROCRUSTES TARGETS AND ONE SOLUTION.

			Varimax			Target 1			Target 2			Solution 1*					
Faculty	Sex	GPA	1	2	3	1	2	3	1	2	3	1		2		3	
Arts	M	H1	70	49	05	+1	+1	0	0	+1	0	31	*40*	62	*46*	17	*27*
		H2	75	28	06	+1	+1	0	0	+1	0	49		31		38	
		M1	14	55	47	0	+1	0	0	0	+1	−46	*−12*	72	*71*	08	*10*
		M2	68	47	11	0	+1	0	0	0	+1	22		70		12	
		L1	17	49	35	−1	+1	0	0	−1	0	−29	*−40*	57	*60*	13	*20*
		L2	14	49	62	−1	+1	0	0	−1	0	−50		62		26	
	F	H1	60	61	17	+1	+1	0	0	+1	0	09	*23*	79	*68*	12	*18*
		H2	74	45	08	+1	+1	0	0	+1	0	36		57		24	
		M1	48	68	15	0	+1	0	0	0	+1	−03	*−15*	87	*56*	−01	*28*
		M2	21	34	62	0	+1	0	0	0	+1	−26		25		57	
		L1	38	71	11	−1	+1	0	0	−1	0	−20	*−09*	92	*77*	−12	*06*
		L2	49	54	27	−1	+1	0	0	−1	0	02		62		24	
Science	M	H1	88	06	16	+1	0	+1	+1	0	0	51	*42*	29	*23*	41	*52*
		H2	72	11	37	+1	0	+1	+1	0	0	33		17		63	
		M1	27	−17	76	0	0	+1	0	0	+1	−08	*−11*	−30	*16*	93	*55*
		M2	29	62	28	0	0	+1	0	0	+1	−15		62		17	
		L1	03	33	63	−1	0	+1	−1	0	0	−47	*−30*	34	*37*	38	*44*
		L2	35	47	50	−1	0	+1	−1	0	0	−13		−40		49	
	F	H1	81	25	15	+1	0	+1	+1	0	0	44	*35*	39	*36*	39	*44*
		H2	66	28	31	+1	0	+1	+1	0	0	25		34		48	
		M1	53	19	30	0	0	+1	0	0	+1	29	*13*	06	*05*	61	*67*
		M2	39	11	62	0	0	+1	0	0	+1	03		04		73	
		L1	13	29	66	−1	0	+1	−1	0	0	−41	*−37*	33	*13*	44	*58*
		L2	03	09	70	−1	0	+1	−1	0	0	−33		07		67	

(Decimal points omitted; 4 *S*s per cell.)

* Solution 2 resulted in a factor collapse.

In the event, the second pattern could not be matched: there was a factor collapse. The first was, however, approximated fairly closely as can be seen in Table 1. Further, it is seen that the replicated cells gave loadings that were in most cases close to each other: the pattern becomes clearer if the means of the replicated cells are taken (italicized figures). The analysis thus far supports the hypothesis that there is a general pattern of study behaviour that is related to achievement irrespective of faculty membership, but that specific faculty patterns also exist.

The next step was to distinguish the items that had high factor scores on each of the three factors: the procedure here is identical to obtaining factor scores for people in a normal R-analysis. It was found that using a cutting point of ±1·30 σ yielded a reasonable number of items per scale. In this way, some 32 items were used out of the original 80 that were specifically selected because they discriminated people either on the basis of high or low achievement in general, or with respect to membership in Arts and Science (sex, as can be seen in Table 1 did not differentiate, and served basically as another replication). The three Q-scales were composed of R-scale items as follows:

*Q*1: *Achievement through cool* (α= ·675; 12 items)
Study skills (6); Academic interest (1); Internality (−1); Test anxiety (−1); Academic neuroticism (−3).

*Q*2: *Arts—Own thing* (α= ·530; 15 items)
Academic aspiration (−5); Study skills (−3); Internality (2); Meaning assimilation (2); Openness (3).

*Q*3: *Science—Hard nosed* (α= ·420; 13 *items*)
Academic aspiration (2); Study skills (2); Restrict interest to prescribed material only (4); motivated by exams (1); Externality (1); Copes with assignments (2).

Although the R scales were unidimensional, the Q-scales were composed of individual items of the R-scales, which were synthesised into Q-scales yielding Cronbach alphas that were at least no worse than the R-scale ones.

COMPARISONS BETWEEN Q AND R SCALES

(1) *Prediction of first year performance.*

Although linear prediction is not relevant to the ATI issue, it is, nevertheless, interesting to ask how effective the two kinds of scale are in predicting first year performance (GPA). At this stage of the analysis, and for ensuing analyses, only those students with complete high school and university performance data, and who had not been selected for the Q analysis, were retained : this left a total of 361 students.

In order to test the predictive powers of the two sets of scales (and given that the scales were not orthogonal in either set) a series of stepwise multiple regressions was calculated, with high school performance (HS) and the 10 R-scales as predictors in one case, and HS and the 3 Q-scales as predictors in the other, with university GPA (first year results) as the criterion in both sets of regressions. The results are given in Table 2.

TABLE 2

Stepwise Regressions of High School and (*a*) R-scales, (*b*) Q-scales, on GPA (P< ·05).

(*a*) *R-scales*	Arts				Science			
	Male		Female		Male		Female	
Step	Pred.	Cum.%	Pred.	Cum.%	Pred.	Cum.%	Pred.	Cum.%
1........	HS	23·9	HS	32·1	HS	48·2	HS	60·9
2........	R3	29·7	—	32·1	R5	53·0	R5	67·8
3........	—	29·7	—	32·1	R4	55·0	R6	72·6
4........	—	29·7	—	32·1	—	55·0	R9	74·7
(*b*) *Q-scales*	Arts				Science			
	Male		Female		Male		Female	
Step	Pred.	Cum.%	Pred.	Cum.%	Pred.	Cum.%	Pred.	Cum.%
1........	HS	23·9	HS	32·1	HS	48·2	HS	60·1
2........	Q1	28·6	—	32·1	Q1	54·6	Q1	68·0
3........	Q2	32·0	—	32·1	Q2	56·3	Q2	70·7

As can be seen, HS enters into all regressions, and the study behaviour scales into most. There is little between the amount of variance accounted for by the two kinds of scale. Considering, however, that the latter use only 32 items and the former 80, the advantage of the Q-scales in terms of sheer economy is clear.

(2) *Presence of ATI.*

The regressions, of course, do not say anything about ATI. The major hypothesis in this study was that Q-scales would be more likely to yield interactions with treatment than R-scales. Accordingly, a series of multivariate analyses of variance (MANOVAs) was run, with Faculty, Sex and two each of the R and of the Q scales as independent variables, and high school performance and GPA as dependent variables in that order. These analyses were repeated until each R and Q scale had been combined with Faculty and Sex at least once. In this way main effects and interactions of Faculty, Sex and each of the 10 R-scales and three Q-scales on high school performance, GPA and (more to the point) GPA adjusted for high school, were obtained. The results are summarised in Tables 3 and 4.

TABLE 3

SELECTED MANOVA RESULTS: F-RATIOS FOR MAIN EFFECTS AND SIGNIFICANT INTERACTIONS INVOLVING R AND Q-SCALES.

	HS	GPA	Step-down	Multivar
Sex (S)	<1	<1	2·45	1·30
Faculty (F)	42·90†	13·49†	<1	21·59†
S×F	<1	<1	2·44	1·52
R main effects				
Ac. Asp. (R1)	3·34	6·19*	2·92	3·14
Ac. Int. (R2)	2·86	8·76†	5·88*	4·39*
Ac. Neur. (R3)	<1	11·86†	13·78†	7·32†
Internal (R4)	2·29	<1	1·14	1·71
Stud. Sk. (R5)	<1	7·09†	15·62†	8·01†
Rote (R6)	15·33†	14·69†	2·97	9·19†
Dep. (R7)	10·68†	3·45	<1	5·36†
Mean (R8)	<1	<1	<1	<1
TA (R9)	10·33†	6·30*	<1	5·34†
Open (R10)	<1	1·03	1·15	<1
R. interaction				
R4×S×F	<1	3·72	7·29†	3·67*
R6×S×F	<1	6·10*	7·65†	3·95*
R8×S×F	<1	2·88	8·27†	4·52†
Q main effects				
Q1	3·49	24·53†	23·68†	13·71†
Q2	2·31	3·43	1·30	1·81
Q3	1·33	<1	<1	<1
Q interaction				
Q1×F	1·07	1·50	6·00*	3·54*
Q2×S×F	4·44*	<1	3·79*	4·14*
Q3×S×F	1·24	<1	4·75*	3·00*

* P< ·05. † P< ·01

TABLE 4

UNADJUSTED GPA MEANS SHOWING INTERACTIONS INVOLVING R AND Q-SCALES.

(*a*) *R-scale interactions*

Sex	Faculty	Scale	R4 Intern	R6 Fact-rote	R8 Mean
M	A	Hi	11·6	10·9	11·3
			(+·4)	(−1·0)	(−·2)
		Lo	11·2	11·9	11·6
	S	Hi	12·0	12·3	12·4
			(−·8)	(−·9)	(−·7)
		Lo	12·8	13·2	13·1
F	A	Hi	12·3	11·9	11·9
			(+·5)	(−·2)	(−·3)
		Lo	11·8	12·1	12·2
	S	Hi	13·1	11·5	13·5
			(+·8)	(−2·9)	(+1·1)
		Lo	12·3	14·4	12·4

(*b*) *Q-scale interactions*

Sex	Fac.	Scale	Q1 Ach.		Q2 Arts		Q3 Sci.	
			HS	GPA	HS	GPA	HS	GPA
M	A	Hi	143·2	12·3	140·0	12·0	141·2	11·2
			(+6·0)	(+1·4)	(−7·7)	(+·7)	(+1·8)	(−·8)
		Lo	137·2	10·9	147·7	11·3	139·4	12·0
	S	Hi	148·9	13·3	154·4	12·8	148·5	12·5
			(−1·7)	(+1·4)	(+7·7)	(+·4)	(−1·5)	(−·2)
		Lo	150·6	11·9	146·7	12·4	151·0	12·7
F	A	Hi	142·1	12·5	142·1	12·3	142·1	12·5
			(+2·5)	(+·9)	(+5·0)	(+·5)	(+2·5)	(+·6)
		Lo	139·6	11·6	138·1	11·8	139·6	11·9
	S	Hi	153·5	14·0	152·4	12·7	154·9	12·7
			(+3·6)	(+2·7)	(−·1)	(+·1)	(+5·5)	(+·4)
		Lo	149·9	11·3	152·5	12·6	148·4	12·3

In Table 3, the F-ratios for the various effects are given, and indexed for significance at the ·05 and ·01 levels. In the first column (HS), the student's previous year's high school aggregate is the dependent variable; in the next column (GPA), the dependent variable is GPA in first year subjects; in the column headed 'Step-Down,' the F-ratio for GPA is adjusted for the same effect on HS (HS and GPA correlate on average + ·60) and is identical at this point to an analysis of covariance on GPA, with HS as covariate; and in the final column 'Multivariate,' the F-ratio for the difference between the strength of the effect on HS and on GPA is given, so that where this ratio is significant, it means that the effect on HS is significantly different from that on GPA.

As the first three rows show, there are no sex effects on interactions with faculty with respect to performance. There are, however, significant faculty effects. On high school aggregate, Science entrants have much higher scores than Arts entrants; the Science superiority remains when comparing on unadjusted GPA but it entirely disappears when the initial inequality is taken into account. This difference between effects at high school and at university is itself highly significant.

The next ten rows give *R*-scale main effects. Three scales (Internality, Meaning and Openness) show no effects at either school or university; Aspiration shows similar effects at both school and university—those with purely pragmatic aspirations perform badly; Rote, Dependence and Text Anxiety affect performance in high school significantly more than in university, while Academic Interest, Academic Neuroticism and Study Skills are relevant only to university performance. Neuroticism depressing, the others enhancing, performance.

Only three R-scales showed interactions with faculty, and in all cases the effects were different across the sexes. The means (unadjusted for HS) are given in Table 4. Unfortunately, this program does not print out the cell means at each step-down and so where there are significant effects on HS, the nature of the effect on adjusted GPA may be difficult to determine. This situation does not arise in the case of the R-scale interactions, and the nature of the effects can be seen in Table 4 (a). Internality (4) exerts a mild enhancing effect in Arts for both males and females. In Science, however, there is a clear interaction: males do better with an external stance, while females do better with an internal stance. It seems that males and females perceive the Science task in quite different ways, as the other two interactions also suggest.

While a fact-rote orientation (R6) is consistently associated with poor performance, there are clear differences in the strength of this association, according to faculty-sex membership: it is weakest in Arts females, and far the strongest in Science females. Again, a strategy of assimilating new knowledge to existing knowledge (R8) is negligible in Arts, is detrimental to Science males, but evidently useful for Science females.

While these interactions are not without interest, they are clearly not those expected under an ATI model, or on the basis of the writer's previous work (Biggs, 1970a). The evidence is not here that there are two different tasks involved in Arts and Science and that different strategies of approaching them will optimise performance, but that the same task may be attempted in two different ways: if by a male, by seeing ' truth ' as emerging from external sources and authorities, and not worrying too much about inter-relating past knowledge with what one is in process of acquiring ; and if by a female, by making up one's own mind about ' truth,' by avoiding rote learning of detail, and by actively using transformational strategies.

In common with the Australian study (Biggs, 1970a), then, two patterns of study behaviour, reproductive and transformational, appear, and *either* may be used by the appropriate person successfully. The moderating variable here, however, does not appear to be faculty membership.

Q-scale main effects are simple: one massive Achievement (Q1) effect on GPA with a non-significant effect on HS, which reflects the fact that the Q-scales were derived to maximise university-specific effects. Neither Q2 nor Q3 are related to GPA.

The Q-interactions are difficult to interpret because the GPA means adjusted for HS were not available. The high school means with the GPA means are included. The Q1 × F interaction seems to suggest that Q1 is more closely related to Science than to Arts performance (when the HS differences across the cells are taken into account); certainly ' achievement through cool,' the designated Q1 syndrome, would appear to be more related to Science than to Arts (the Procrustes loadings in Table 1 for Q1 are arguably more strongly articulated in the Science than in the Arts subgroups).

Q2 × S × F is very difficult to interpret, in view of the total lack of pattern ($F<1$) in the unadjusted means. An attempt to merge the unadjusted means with the significant differences existing in HS means might suggest that Q2 represents an effective Arts stance, and an ineffective Science stance, for males only; it being *in*effective for female Arts and irrelevant to female Science.

Q3 × S × F is hard to interpret for the same reason. In general, it would appear that the hard-nosed approach to study is moderately suitable for Science males and Arts females; but unsuitable for Arts males and Science females.

CONCLUSIONS

This study was an attempt to link one interpretation of the ATI model to research in the area of faculty differences in study behaviour. There are two distinct questions here: (i) are Arts and Science students distinguishable in terms of stable, trans-situational attributes; and (ii) are the demands of Arts and Science such that optimal success demands a specific ' mix ' of personological attributes? The first question is one that has received the entire weight of previous research (such as there has been) and is conceived here in R-analysis terms. The second has received no prior study, despite the fact that it is possibly more consistent with Cronbach's original ideas on ATI.

With respect to the first question, previous work by this writer seemed to indicate that faculty differences in study behaviour were accountable as follows: in Arts, either of two general strategies could work, namely reproductive or transformational, and in Science prior content mastery was more important than strategy. Goldman and Warren (1973), on the other hand, suggest that strategy differences *per se* are irrelevant: they distinguished similar kinds of strategy to the Biggs ones, but suggest they work, or not, whatever the content area, and that value orientations (pure/applied) are more likely to yield faculty differences. In the present study, certainly the transformational/reproductive distinction was confirmed, but this time there appeared to be sex interactions with faculty: females being more likely to use a reproductive approach in Arts and a transformational one in Science, but males using transformation optimally in Arts and reproduction in Science.

It thus appears that there are alternate roads to academic success, but whether they are discriminative of faculties might well depend on institutional or other non-generalisable factors. The kinds of thing that could affect this interaction are, of course, many: examination techniques, use of seminar and lecture presentations, stress on set texts, and so on, any one of which is applicable to either Arts or Science. Certainly this writer's original analysis of ' the Arts task ' and ' the Science task ' does not seem as generalisable as the earlier study indicated.

The Q-analysis supports these general trends. Without analysing in detail the Faculty × Q interactions that emerged, the original factor analyses showed a general high achievement factor could plausibly be fitted across both sex and faculty, although it was marginally clearer in Science. This general achievement factor consisted of a mixture of various unidimensional R-scales—mainly certain study skills, low anxiety, and willingness to be externally controlled—which gives a consistent picture of a determined, if somewhat uninteresting, type of high achiever (see also Entwistle and Brennan, 1971) who will do well whatever he tackles. The other Q factors are relatively minor: the so-designated Arts factor gives the familiar picture of the 'far-out creative,' and the so-designated Science factor, the ambitious, hard-nosed worker. Of these three factors, the first not unnaturally contributed fairly strongly to the achievement variance, and the second one slightly more. The hard-nosed scale did not improve straight linear prediction at all.

Finally, a brief work on the 'situation-specific' (Q) approach. It was used here within the context of study methods. Q-technique could, however, be applied to the standard ATI situation, but with treatments determining the point of departure, not a set of Text Anxiety scores (or what have you). Using whatever performance, pencil-and-paper, or other information one has, it should be possible to discover whether or not one mix of characteristics defines (for example) the individual who does well under expository methods and another mix the high achiever under self-directed methods. In this way, we might find out something more about that most crucial of factors: the *functional relationship* between the reactions of different students to different educational environments.

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RESEARCH NOTES

Br. J. educ. Psychol., 46, 81-84, 1976

THE PROCESSING OF DIGITS BY CHILDREN WITH SPECIFIC READING DISABILITY (DYSLEXIA)

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SUMMARY. The present study compared the processing of single digits by two groups of 20 dyslexic children with a control group. A single digit (0 through 9) was presented for 20 msec followed by a mask for 20 msec at ISIs of 8, 16, 24, 32 or 40 msec. Both dyslexic groups had significantly more correct identifications than the control group, but did not differ from the control group in their reaction time. Analysis of error patterns showed that a large number of the dyslexics consistently confused the digits having curved features.

INTRODUCTION

Levine *et al.* (1973) investigated the processing of numerical inputs by means of an over-printing or masking paradigm. After varying time intervals a digit was followed by a noise mask and subjects were required to recognise it. They found major differences in the ease of recognition of various numbers. Recognition curves showed different rates of recognition for different digits. Large differences were also found in processing ability between different subjects. Using a similar masking paradigm, Stanley and Hall (1973) found a difference between children with specific reading disorder (dyslexia) and controls in the time taken to process letters. Dyslexics were slower than controls and there were differences between letters, but no significant letter x group interaction.

In the experiment reported here, dyslexic children are compared with controls in their processing of single digits. The rationale for the present study relates to a concern to identify if there are specifically unique aspects of how dyslexic children process visual information. Within the vast literature on dyslexia (see Hallahan and Cruickshank, 1973, for a recent review) there has been considerable debate between those who assert that dyslexics process information in a distinct and unique way, and those who consider that dyslexics differ from normals only in capacity. A masking paradigm was used in the present experiment, but reaction time for identification was also measured, as Blank *et al.* (1971) have indicated that dyslexics may have a slower reaction time than controls.

METHOD

Sample.

Three groups of children were chosen: Group I comprised 17 male and three female children aged between 8 years and 9 years 9 months. These children were selected from a large sample of primary school children drawn from the greater Melbourne area and tested by the reading research group of the Victorian Education Department. The criteria of selection as dyslexic were as outlined by Stanley and Hall (1973). Group II consisted of 12 males and 8 females aged between 9 years 3 months and 12 years 3 months who were at least 24 months behind age level on the GAP reading comprehension test (McLeod, 1967), and whose mean WISC performance IQ was in the normal range. Group III comprised 12 males and 8 females chosen within the same age range as Group II, but whose scores on the GAP test were within the normal level for their ages. Groups II and III came from inner suburban schools and did not differ on their mean WISC performance IQ. The other criteria of selection of dyslexics and controls were identical to previous studies in this project (Stanley and Hall, 1973; Stanley, 1975).

Apparatus.

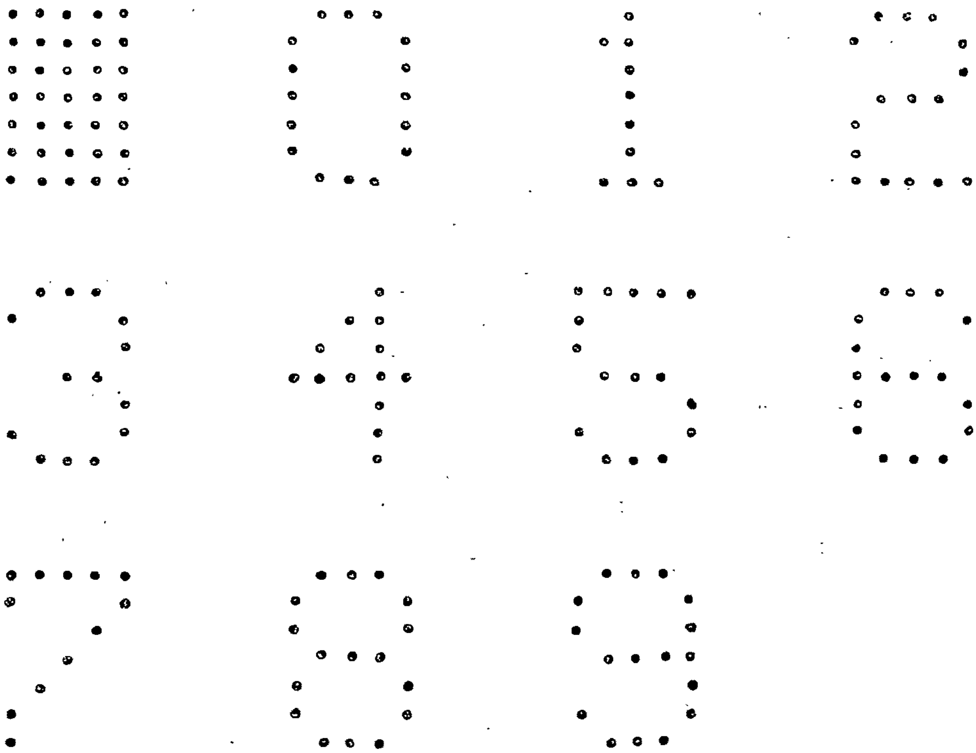
Stimuli were presented in an Hewlett-Packard cathode ray oscilloscope under the control of a PDP 11/20 computer. The CRO had a P-15 low persistence phosphor. A 10-button response console was also interfaced to the computer.

Stimuli.

The stimuli were the 10 digits from 0 to 9, composed of single dot elements derived from a 5×7 element matrix (see Figure 1). The mask consisted of a 35 element matrix which was spatially superimposed on the digit at varying ISIs. The children sat at a distance of approximately 370 mm from the oscilloscope and the stimuli were 30 mm in height.

FIGURE 1

THE DIGIT SET AND MASK.



Experimental Design.

A digit was displayed for 20 msec followed by the mask for 20 msec at ISIs of 8, 16, 24, 32 or 40 msec. The digits were presented in random order over digit and ISI within each block of 50 stimuli. Each block was repeated six times, the first block being considered a practice set. Reaction time was measured from stimulus onset to response.

Procedure.

Children were tested individually and instructed to press the appropriate button to indicate which number appeared on the screen. Each of the 10 response buttons was labelled with the appropriate digit label. They were instructed to guess if they were not sure which number was presented, but not to press the same button each time they guessed. The practice block permitted an opportunity to correct stereotyped guessing responses.

RESULTS

The results are presented in terms of three separate analyses: number of correct identifications, reaction time, and error pattern.

Correct Identification.

The number correct identifications out of the five presentations for each experimental condition formed the score for each subject. The mean number correct averaged over all conditions was 3·83 for Group 1, 3·50 for Group II, and 2·84 for Group III. This result shows that overall the dyslexics performed at a higher level than the control group. Orthogonal comparisons showed that the control group differed from the two dyslexic groups ($t=4{\cdot}05$, df 57, $P<{\cdot}01$) but the two dyslexic groups did not differ from each other in mean performance ($t=1{\cdot}25$, df 57, $P>{\cdot}05$). Analysis of variance on the scores showed a significant group effect ($F(2, 57)=5{\cdot}21$, $P<{\cdot}01$), a significant effect due to ISI ($F(4,228)=41{\cdot}16$, $P<{\cdot}01$), non-significant group x ISI interaction ($F(8,228)<1$, $P>{\cdot}05$), a significant digit effect ($F(9,513)=35{\cdot}71$, $P<{\cdot}01$) and a non-significant group x digit interaction ($F(18,513)=1{\cdot}48$, $P>{\cdot}05$).

Reaction Time.

The average reaction time for the five presentations for each experimental condition formed the score for each subject. The mean RT averaged over all conditions was 181·67 msec for Group I, 173·84 msec for Group II, and 193·75 msec for Group III. Contrary to Blank *et al.* (1971) the dyslexics responded slightly faster than the controls. However, analysis of variance showed that this trend was not significant ($F(2,57)=1{\cdot}36$, $P>{\cdot}05$). The ISI factor was significant ($F(4,228)=2{\cdot}53$, $P<{\cdot}05$), the group x ISI interaction was not significant ($F8,228)<1$, $P>{\cdot}05$), the digit factor was significant ($F(9,513)=7{\cdot}72$, $P<{\cdot}01$), but the digit x group interaction was non-significant ($F(18,513)<1$, $P>{\cdot}05$).

Error Patterns.

A computer program (Program H-Group) given in Veldman (1967) was used to isolate groups whose error profiles were as similar as possible. This program initially treated each subject's error scores for each digit as a group, and proceeded to combine first subjects and then groups of subjects. After each grouping was made the program gave an error function which reports the amount of additional variance introduced by treating two groups as one group on the next level down, etc. A sharp jump in the error function provides a useful criterion to stop the combination of groups. Such a jump occurred after nine groups. The largest group had 30 subjects, 25 of whom were dyslexics. The remaining groups were composed of a mixture of dyslexics and control subjects, four having one or two members with the remaining groups being no larger than six.

TABLE 1

FREQUENCY OF ERRORS MADE BY 25 DYSLEXICS WITH HIGHLY SIMILAR ERROR PROFILES.

Digit Presented	Errors										
	0	1	2	3	4	5	6	7	8	9	Ex
0	x	6	2	2	6	4	5	0	9	4	38
1	30	x	0	4	7	2	3	1	2	0	49
2	2	15	x	17	0	7	2	0	3	2	48
3	9	6	23	x	8	19	17	6	39	20	147
4	2	2	0	3	x	0	2	2	0	5	16
5	1	0	3	2	3	x	35	3	7	5	59
6	1	1	6	8	5	61	x	6	35	13	136
7	6	5	33	7	2	6	14	x	7	3	83
8	11	4	16	54	2	23	51	9	x	40	210
9	11	3	10	21	5	24	23	4	53	x	154

The confusion matrix obtained from the 25 dyslexics from the largest group is shown in Table 1. Clearly the dyslexics tend to have most errors on 3, 6, 8 and 9. The most common confusions for 3, were 2, 8 and 9; for 6, they were 5 and 8; for 8, they were 3, 6 and 9; and for 9, they were 3, 5, 6 and 8.

DISCUSSION

Analysis of both the number correct and reaction time showed no significant group x ISI or group x digit interaction. The novel result was the finding that dyslexics perform better than controls on digit identification. This result is particularly of interest in view of the finding (Deese, 1972; Stanley *et al.*, 1975) that dyslexics generally have shorter digit spans than normals.

Analysis of errors made showed that 25 out of the 40 dyslexics in the sample had a similar error profile. The main characteristic of this error profile is that dyslexics appear to have difficulty mainly with digits having curved features, making more errors with these digits and confusing them with other digits having curved features. The error patterns for the other subjects did not show any such simple pattern.

One possible explanation for the present result is that dyslexics may have primarily used a visual code in making their response, matching the displayed digit to the digit on the response console. Stanley (1975) has provided evidence that dyslexics have longer visual persistence than controls, perhaps accounting for their better identifications in the present study. The finding that the error patterns for many dyslexics reflect confusions relating to curvature, for digits with curved features, is consistent with the notion that they are responding in terms of visual trace. It may not necessarily imply a great difficulty for the dyslexics in processing curvature as such.

The present results have shown that dyslexics process single digits at the same rate as controls and tend to be marginally more accurate than controls. Difficulties with larger sets of digits, as in digit span tasks, presumably is due to a capacity limitation.

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THE PENDULUM PROBLEM

By M. SHAYER

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SUMMARY. Comparison is made between the very high proportion of adolescents found by Somerville to be formal operational thinkers, and the much lower proportion found by Lovell. Evidence about the representativeness of Somerville's sample is analysed suggesting that it is comparable with that of an average English selective school. When allowance is made for the difference in populations the results are shown to be not in conflict.

INTRODUCTION

Comparison of Lovell's original replication study (Lovell, 1961) with Susan Somerville's recent article on the pendulum problem (Somerville, 1974) prompts the question: why did the latter find so much higher a proportion of formal operational thinkers among the adolescents she tested, and why did she find no Stage IIA subjects, even among the 10-year-olds? These questions are irrelevant to the achieved purpose of that article (which was to define detailed descriptions of performance characteristic of different developmental stages on that problem), but they do concern any worker in curriculum development who wishes to know what proportion of, say, 12-year-olds can be expected to be early formal operational thinkers. The first study suggests an answer of 15 per cent; the latter 75 per cent.

DISCUSSION

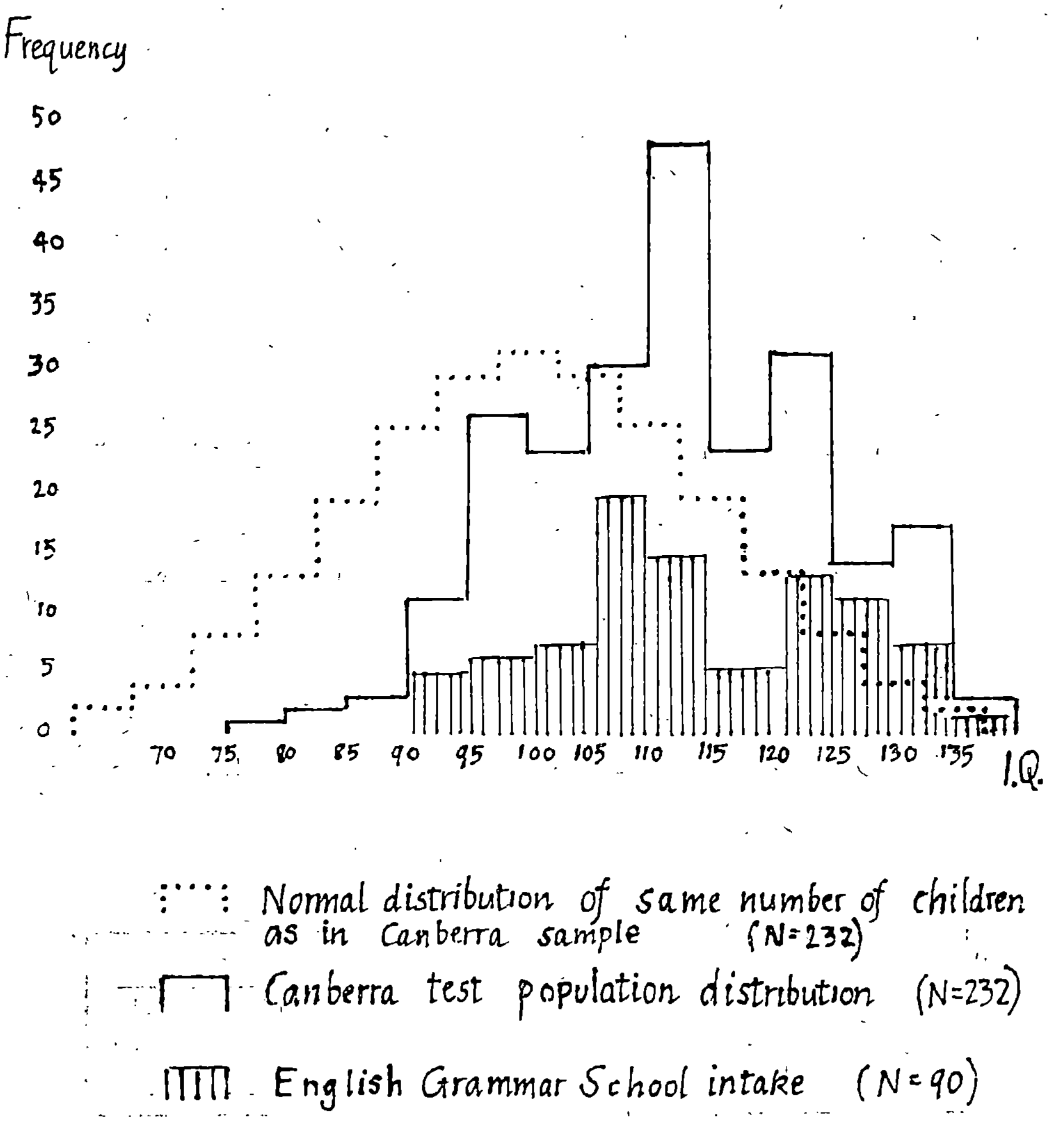
Somerville used two measures in order to select, from the schools studied, a representative sample of children: Raven's Matrices raw scores and the schools mathematics marks. Since it was not her purpose to generalise to the child population as a whole, she has kindly allowed the author access to the original data so that he might attempt this. As the Standard Progressive Matrices have been standardised on a representative Australian population (ACER, 1966), it is possible to derive an IQ figure for each of the first three years studied (Table 1). These figures cannot be very precise, since they were estimated by taking the mid-point of the range within which ACER reported mental ages as corresponding to a given raw score.

TABLE 1

RAVEN'S MATRICES SCORES FOR SOMERVILLE'S SAMPLE.

	Age group (years)				
	10	11	12	13	14
SPM-mean raw scores	35·85	38·98	40·79	41·77	43·14
Mean MA (months)	155	165·5	198·5	—	—
Mean IQ	123	121	132	—	—

Fig. 1


Frequency
50
45
40
35
30
25
20
15
10
5
0
70
75
80
85
90
95
100
105
110
115
120
125
130
135
I.Q.
Normal distribution of same number of children as in Canberra sample (N=232)
Canberra test population distribution (N=232)
English Grammar School intake (N=90)

This gives a mean IQ for the first three years of the population studied of 125, which would mean that the sample was representative of only the top 8 per cent of the Australian child population. As this seemed somewhat surprising, a more detailed comparison was made using an "Assessed IQ" for each child which had been arrived at by the school counsellors using the results of two ACER standardised verbal reasoning tests: the Junior B at around 9 years of age, and the Intermediate D at around 11 years of age. These records were available for 232 of the 236 children studied by Somerville in the age-range 10 to 14. The mean Assessed IQ was 112, and the detailed distribution is given in Figure 1, together with a histogram of a normal distribution around a mean of 100 and standard deviation of 15 for the same number of subjects. For British readers in particular, the distribution of standardised scores for 90 11-year-old pupils in a selective grammar school in the North Midlands are added, as this school also had a mean IQ of 112 in their intake (by Calvert Non-Verbal Test DH, NFER).

These histograms indicate a general answer to the first question: whereas Lovell's population was a little below average, Somerville's was considerably above average, and for curriculum planning purposes can be taken only as giving information about that part of the population which in England has been chosen for entry into selective schools (say the top 20 per cent). For an answer to the second question it is only possible, in the absence of measurements made on a large and nationally representative population, to make a hypothetical answer. In the whole sample of 236 children, there were only two in the MA range 10 to 10½ by SPM, and 6 in the range 10½ to 11. In Table 2 of Somerville's article (p. 276) it can be seen that only 13 children's performances were categorised below the IIB level (late Concrete Operational). Since the instance Piaget himself quotes as exhibiting IIA performance was that of an 8-year-old (Inhelder and Piaget, 1958, page 70), and since Lovell showed that this level of performance could be found in 23 children out of 50, aged 11 and above, the most reasonable explanation, it is suggested, is that Somerville's population was above the cut-off point where there would be any probability of finding a child with a performance characteristic of the average 8- or 9-year-old. The schools she used were non-selective state schools in Canberra, and her sampling method ensured that among those schools the children tested were strictly representative. It appears that neighbourhood schools can find themselves with as stratified a child population as those for which the selection has been deliberate.

Taking the IQ mean of 112 as indicating that the school population used was characteristic of the upper third of the Australian child population would bring the proportion of children exhibiting early formal operational thinking (IIIA) down from 75 per cent to 25 per cent—a figure more in line with Lovell's findings.

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Br. J. educ. Psychol., 46, 88-93, 1976

INTERVIEWS AS AN AID TO SELECTION OF PSYCHOLOGY UNDERGRADUATES

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SUMMARY. The relationships between class of degree in psychology from one department and (*a*) interview ratings, (*b*) two adult intelligence tests, and (*c*) advanced-level examinations were examined in a sample of 145 students from four year-groups. Roughly the same amount of variance of degree class could be accounted for by using the interviewer rating and intelligence test scores as by using prior academic performance. The best prediction combination included both interviewer ratings and A-level performance.

INTRODUCTION

Predicting the final examination performance of prospective students three years before they sit the examination is a difficult task, yet it is the one faced by most university departments. Studies of students already selected show that about 10 per cent ($r=0{\cdot}3$) of the finals variance can be accounted for by using A-level performance and about 6 per cent ($r=0{\cdot}25$) using headmasters' ratings. With multiple regression, about 16 per cent ($R=0{\cdot}4$) of the variance can be accounted for using O-levels, A-levels and headmaster assessment (Choppin *et al.*, 1973; Entwistle, 1974). Science faculties have the best success in this type of prediction while arts faculties have the worst (Entwistle *et al.*, 1971). Personality variables have been less consistent predictors (Kline and Gale, 1971). In the present study the relationship between an interview rating and university success is examined.

METHOD

The sample used in this study is more restricted than those in the other studies mentioned. It is comprised of about 145 students in one psychology department over a six-year period when there were no major syllabus changes. An interview and some aptitude tests were given to each candidate in the February before his October registration.

Although A-level results are included in the analysis to be reported, since selection takes place in February before the A-level exams, the marks are not known. Offering of places is made conditional on only two E's. Esentially then, passing A-levels is used as a cut-off criterion by this department, permitting more variability in these scores for students.

Sample.

Data from 145 students who did final examinations in psychology at University College, London, in the years from 1969 to 1974 were used. The number doing the final examination in each three-year group varies from 67 to 86 (Table 1).

Selection Procedure.

Undergraduate candidates are invited to come for a 45-minute interview and also complete two adult intelligence tests (to be referred to as Int A and Int B).* Although other tests are given, they are not included in the analyses to be presented here. At the interview, two members of the teaching staff talk to the candidate, having reviewed the UCCA form giving information about O-level performance, and headmaster's report and predicted A-level marks. There is rotation of pairs of interviewers, with each pair working together for one day doing no more than eight interviews. At the completion of the interview, several scales are completed by each interviewer separately and only then do the interviewers exchange opinions about the candidate. Of seven scales the interviewer completes, only one, the recommendation, is used executively.

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* Details of the tests used may be obtained from the author.

The other scales probably help the interviewer make his recommendation. They include ratings on motivation, intellectual competence, sociability, social responsibility, emotional stability, and work habits. The recommendation, a number between 1 (worst) and 7 (best), is weighed heavily in a regression equation along with scaled scores on the Int A and the Int B tests to make up a total selection score for each candidate. This equation is based on a multiple selection score for each candidate. This equation is based on a multiple regression done in 1965, and is called the *total selection* score here. Offers of places are made to candidates after a staff meeting has discussed the various scores and ratings, making 'clinical' decisions in the light of the information available. The total selection score is certainly the most frequently used criterion for these decisions, although values on all seven rating scales are available.

Procedure for this Analysis.

To supplement interview information for this report, A-level data was collected. This comprised:

(1) Sum of A-level marks (coded as A=5, B=4, etc.).
(2) Number of A-levels attempted.
(3) Maximum A-level mark (coded as above).
(4) Minimum A-level mark (coded as above).
(5) Type of A-level (science=0, mixed=1, arts=2).
(6) Whether mathematics was taken at A-level (yes=0, no=1).

The second, fifth and sixth A-level variables are available in the winter before admission of the candidates and so are available as early selection measures. It is worth noting that most students cannot do a psychology A-level.

Additional information on sex (0=female, 1=male) and age of the student was also collected. The age was measured as a deviation from the modal age for the particular year. This measure would detect 'mature' students or those who had delayed entry into university, spending at least one year doing non-academic work.

The criterion variable, finals examination performance, was measured rather grossly for this analysis. Class of degree was either high (first or upper second) or low (lower second or worse). This measure was used since it is probable that the aim of any selection procedure is roughly to classify candidates even though finals attainment at UCL is known to two decimal places (range is from 1·00, best, to 10·00, worst). Also included for continuity with other studies (e.g., Entwistle *et al.*, 1971) is a first year mark on one course unit examination. The particular examination mark is the highest correlate with finals class of all first year assessment scores. These marks range from 1·00 to 10·00 as in finals.

In summary, there are several sources of information about the candidates. Interview scores include a recommendation and two adult intelligence test scores, summarised in a total selection score. *Early selection* scores include items 2, 5 and 6 of the A-level information, the interviewer recommendations, the two adult intelligence test scores, sex and age.

RESULTS

Although each year can be considered separately, we have combined three consecutive years for these analyses. This provides four groups of students, with overlap between groups. One advantage of such a grouping is the reduction in variability due to use of small numbers of students. Since three years of students are present at college at any given time, this classification also seems representative. A grouping technique like this has been found to provide the most stable results while allowing some flexibility due to changing academic circumstances and the student climate (Gough, personal communication).

In Table 1, correlations are presented between finals class and interview recommendation (Rec.), Int A, Int B, and total selection score, the six A-level measures, and three other variables: sex, age, and first-year examination results. Of the early selection measures, the Int A score is generally the best predictor. A-levels show correlations of about 0·27 while there was a correlation of 0·5 between the first year mark and finals class.

TABLE 1

CORRELATIONS BETWEEN FINALS CLASS AND OTHER VARIABLES FOR 3-YEAR-GROUPS.

Groups	N	Interview				A-Level						Other data		
		Rec.	Int. A	Int. B	Tot. Sel.	Sum marks	Max. mark	No. attempted	Min. mark	Maths. attempted	Type (Arts or Sci.)	Sex	Age	1st year mark
69-70-71	67	+0·18	0·23*	—0·22	0·16	0·25*	—0·17	—0·10	—0·09	+0·05	0·23*	—0·09	—0·04	0·46*
70-71-72	74	0·25*	0·26*	—0·26*	0·19	0·27*	—0·22	0·00	—0·27*	—0·06	0·29*	+0·08	—0·08	0·49*
71-72-73	86	0·11	0·18	—0·07	0·08	0·30*	0·03	—0·04	—0·02	0·09	—0·03	+0·09	0·03	0·49*
72-73-74	78	0·16	0·07	—0·05	0·16	0·27*	0·02	0·14	0·18	—0·04	0·03	+0·22*	0·06	0·53*

NOTES :

1. Single asterisks represent significant correlations at 5 per cent level. (Tot. Sel.=Total Selection).
2. The signs of correlations have been altered so that + indicates a direct relationship between the variables. For variables from No. A-levels to age, the signs depend on coding described in the text.

TABLE 2

SUMMARY OF STEPWISE MULTIPLE REGRESSION FOR EARLY SELECTION MEASURES FOR YEAR-GROUPS.

Finals of Students during Year	N	1st var	R	2nd var	R	3rd var	R	4th var	R	Other variables	Total R if use only early selection	R if include sum A	R from A-level alone
1969	67	Int A	0·26*	Type A	0·36*	No. As	0·40*	Int B	0·43*	Maths at A-level, Age, Rec, Sex	0·48*	0·56†	0·38*
1970	74	Int A	0·32*	Type A	0·44*	Rec.	0·47*	Int B	0·49*	Maths at A, Age, No. As., Sex	0·53*	0·61†	0·43
1971	86	Int A	0·24*	Rec.	0·25	No. As	0·26	Int B	0·27	Sex, Maths at A, Age, Type A	0·28	0·41†	0·32
1972	78	Sex	0·20	Rec.	0·28*	Int A	0·31*	No. As	0·33*	Age, Maths at A, Soc., Int B	0·36	0·49†	0·37

NOTES:
* Value significant at 5 per cent level. (Soc.=Sociability).
† Significant increment in R from adding new variables.

It is notable that the total selection score is not the best, nor the most consistent, predictor. Also the recommendation is not highly correlated with class, accounting for only 3 per cent of the variance. Sex (except in the last group) and age were never significantly correlated with degree class.

When stepwise regression is applied on the best early selection measures (not including total selection since it is a function of Int A, Int B and recommendation), R over the groups ranged from 0·29 to 0·53 with eight independent variables. Table 2 shows there is at least some continuity in the variables entered into the stepwise regression. Int A, recommendation, type of A-levels, number of A-levels, and Int B are usually among the first four predictors but the last of these variables shows a negative relationship. Science or mixed A-levels are generally accompanied by better finals class.

When A-level marks are included in the multiple regression there is always a significant improvement in R (at 0·01 level). In terms of percentage of the variance of finals class, early selection measures account for 9 to 28 per cent. With A-level marks included, the percentages vary from 17 to 37 per cent.

If there had been no interview, A-level measures alone would probably be the criteria for selection. The multiple correlation in this situation would range between 0·32 and 0·43. Except for the 1971 and 1972 intakes, R for A-levels is smaller than when early selection measures alone are used.

DISCUSSION

The inclusion of interviews in the present UCL selection procedure can be seen as relatively useful. The interviews provide selection information which differs to some extent from data on prior academic performance, but which is about equally correlated with finals class. The trend, however, seems to suggest lower correlations more recently. This may be due to one year, reversing a number of the trends found in other groups, or due to changing relationships beyond our control. On the whole, with early selection alone, about 16 per cent of the finals variance can be accounted for. This is similar to the results using A-levels and headmaster ratings (Choppin *et al.*, 1973).

Whether the interviews are better than A-level measures is doubtful. The correlations between sum of A-level marks and finals class (Table 1) are always better (though not significantly) than the total selection measure. The multiple regression is always substantially and significantly improved when A-level marks are included. It would seem useful to supplement interview data with A-level marks at UCL, thus accounting for 36 per cent of the finals variance.

Why the correlations in general are so low remains a problem. Homogeneity of the samples is often cited as a reason for this. However, there would be less homogeneity affecting the A-level data here since offers were made conditional only on any two A-level passes. Another possible factor is the time between selection and finals examinations. This is a period filled with change and decision-taking for most students : their reactions at a pre-university time may not reflect their reactions two years later after they have made adjustments to university life. The changing academic situation and student climate will probably have an additional effect. Even in the four year-groups reported on here, there were variations in correlations over time. This may be due to changes in staff selecting students, changes in students, changes in demand for psychology or changes in examination marking. There is no shortage of reasons for low correlations. Larger studies of these trends may be especially helpful in making practical use of these findings to select students, especially ones using data from several departments. Finally, Entwistle and Brennan's (1971) warning that correlational analyses assume there is only one path to academic success also requires consideration.

In conclusion, interviewing has been shown to be useful for undergraduate selection, especially in conjunction with A-level marks, but whether the cost of interviewing, in terms of the funds and effort involved, is justified must be left to the individual department to decide.

ACKNOWLEDGMENTS—My thanks to all members of the UCL department for help on this report, especially Dr. A. R. Jonckheere and Dr. Cecily de Monchaux.

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BOOK REVIEWS

CATTELL, R. B., and CHILD, D. (1975). *Motivation and Dynamic Structure* London: Holt, Rinehart and Winston, pp. xi+287, £6·50.

Professor Cattell is probably best known for his work on intelligence and personality, but he has also made some considerable contributions in the field of motivation. The present volume is mainly concerned with summarising this work, some of which has come from the Illinois laboratory and also much from other research workers throughout the world. The essentials of the theory are the positing of a number of ergs and instincts. These now total 14 and include food-seeking, mating, gregariousness, exploration, self-assertion, aggression and so forth. The list bears a close resemblance to McDougall's, although Cattell's work represents an important advance on McDougall in so far as he has devised measuring instruments for the ergs and in many cases has demonstrated their independence from one another by factorial analysis.

A further point of resemblance with McDougall lies in the theory of sentiments. Sentiments arise from the fusion of a number of ergs which become satisfied through certain outlets, such as people's career, religion, marriage, etc. They constitute broad structures of beliefs, and in turn they generate more specific attitudes to particular objects, people and other phenomena. Ergs, sentiments and personality determine people's behaviour and the second half of the book reviews the principal applications of the theory in the fields of clinical psychology, work and group behaviour. The authors conclude with a review of work on population differences and discuss some of the possible causes of the apparent existence of national differences in personality.

The present volume should replace Cattell's *Scientific Analysis of Personality*, now ten years old, as the most convenient summary of his work for students and it will also be a valuable source book for research workers in this field.

RICHARD LYNN.

DALE, D. M. C. (1974). *Language Development in Deaf and Partially Hearing Children*. Springfield, Illinois: Charles C. Thomas, pp. x+259, n.p.

Senior lecturer in the education of deaf and partially hearing children at the University of London Institute of Education, Dr. Dale is an internationally travelled observer of the teaching of hearing impaired children. *Language Development in Deaf and Partially Hearing Children* contains much of the harvest of these travels. Dr. Dale reports to his readers, sometimes by the statement of principles, sometimes by means of anecdotes or verbatim records, those observations he believes to be of value to teachers and parents of hearing impaired children. The approach is an eclectic one which sometimes suffers from being uncritical but has the virtue of suggesting many practical ideas which will undoubtedly prove useful to all in this field who are able to sift the chaff from the grain.

The book is in two parts. The first deals generally with the question of language development. Chapter I gives accounts of " Some methods of presenting language " under 17 very diverse headings. It might have been more helpful to the reader had the author distinguished between *modes* of communication and *means* of *promoting* communication in the chosen mode. While Dr. Dale comes down unequivocally against non-grammatical sign languages it is notable that he makes very little evaluation of the many varieties of manual communication method which are now becoming fashionable. It may be that Dr. Dale does not wish to confuse his readers in a field which is undoubtedly controversial. Unfortunately, however, the issue is one on which parents, teachers and administrators alike have to formulate some view. It is, therefore, a pity that Dr. Dale does not bring his wide experience and considered critical judgment to bear on this difficult problem. It is surprising to find in this chapter a detailed checklist for teachers planning an educational visit but no checklist on the correct functioning of the child's hearing aid, an altogether more mysterious and daunting procedure for the inexperienced.

The second chapter suggests ways in which parents and houseparents may help to promote the emotional, educational and linguistic growth of their own children or those in their charge. In chapters III and IV, Dr. Dale explains the use of various forms of visual and audio-visual aids and the keeping of pets at home and in the classrooms as means of motivating children to learn. In the last chapter of this section he elaborates his view that more hearing impaired children should be integrated into ordinary schools.

In the second and larger part of the book the author presents more of the lessons and projects which he has used or observed being used successfully in schools for the deaf and partially hearing. Throughout Part I the emphasis is commendably upon motivating children to communicate about their experience, but the ideas in Part II vary in their usefulness for this purpose. The reader needs to keep this important objective in mind when selecting ideas for his own use.

Educational psychologists will be disappointed by this book if they expect, on the evidence of its title, a theoretical and critically argued account, either descriptive or prescriptive, of the development of language in the hearing impaired. However, they may find the book worth recommending to discriminating teachers and parents as a source book of ideas for stimulating communication with these children.

W. D. HINE.

DAVIES, A. (Ed.) (1975). *Problems of Language and Learning*. London: Heinemann, pp. 154, £3·00.

This book is based on a two-day inter-disciplinary seminar on Language and Learning held in Edinburgh in January, 1973, under the sponsorship of the Educational Research Board of the Social Science Research Council. It contains the text of five pre-circulated papers by the major contributors, each followed by a revised version of the prepared comments of a discussant. There are also edited extracts of general discussions which followed the individual papers and occupied the final session, and concluding remarks by the chairman, B. Bernstein.

M. A. K. Halliday presents a model of learning through language in which there is an intentional over-emphasis on the importance of language in the socialisation of the child and in cultural transmission. This paper is not alone in having little to offer the experimentalist though it is itself evidence of the validity of a sociolinguistic account. H. H. Speitel discusses dialect in terms of regional variations in pronunciation rather than in vocabulary or syntax. He postulates ' Scottish Standard English ' pronunciations which school teachers accept and deviations which they correct. J. S. Bruner deals with language as an instrument of thought. His paper has subsequently been revised (with Peterson) but the book presents the original and an editor's abstract of the revision. Bruner proposes that the attainment of abstract thinking in language, at a level comparable with Piaget's formal operations, requires the development of ' analytic competence ' which is distinct from linguistic competence and communicative competence. Margaret Clark reviews research trends in language and reading and cites some two dozen references, many recent and none earlier than 1960. The emphasis is on the normal reader rather than on reading difficulties. J. Britton considers the teaching of writing (as composition) and describes a taxonomy of writing but has comparatively little to say about the London Writing Research Unit with which he is associated.

The seminar reported in this book was the first and more theoretical of two seminars planned to complement each other. Although the present volume is self-contained, it necessarily reflects the inadequacy of theory and the gulf between theoretical and applied research in its subject area. The book represents a diversity of viewpoints without pointing the way to a more integrated approach. It is the kind of book that few readers will want to read entire, though many may want to read it in part. While one welcomes a book that is not prohibitively priced, it is more suitable for purchase by libraries than by individuals.

M. R. MURRAY.

GETZ., W., WIESEN, A. E., SUE, S., and AYERS, A. (1974). *Fundamentals of Crisis Counselling*. Lexington, Mass.: Lexington Books, pp. xiv+184, £6·15.

This is a very good book. It is firmly grounded in clinical psychology and psychotherapy and casework practice. The range of references covered and the manner in which these sources are used to support each step of the argument is most impressive as is also the discipline and clarity with which these varied and often complex ideas are organised and presented. It is consummately written in crisp unambiguous English, free from the threadbare clichés and tired jargon one finds so frequently in recent publications in the counselling area.

While the basic goal of crisis intervention is seen as that of providing immediate, intensive, short-term help to enable clients in crisis to regain equilibrium, the authors draw attention throughout to the potential for growth inherent in the crisis experience. They begin by discussing counselling techniques in relation to psychoanalytic and non-psychoanalytic forms of treatment, carefully defining the field, stating their approach and philosophy and indicating the qualities needed to put the latter into practice. A discussion of possible techniques of value in implementing the stated goals is followed by what is probably the most thorough discussion of crisis interviewing available in print, covering both extended crisis contacts involving multiple sessions and the single-session interview in which the job must be done at one sitting.

The second part of the book is devoted to the presentation of case examples selected to represent a range of situational crises requiring counselling help. Each set of interviews is conducted by a counsellor under supervision and each transcript is followed by the authors' explanation of how the case should have been handled. At key points, readers are invited to try organising the interview material themselves on the basis of the plan put forward by the authors in the first part of the book. The case histories are excellently chosen and presented and the analyses of the material penetrating and incisive.

Though telephone counselling and referral services are familiar in this country, it can be said that the important aspect of helping dealt with in this book is not yet thought of as requiring a separate and distinctly professional role. The authors' examination of the crisis situation, however, amply supports their assertion that concern for people, though necessary, is not sufficient. For those, then, who wish to acquire the technical skill and good judgment clearly essential for success in counselling of this kind *Fundamentals of Crisis Counselling* will be an invaluable reference book. It could also be read and studied with profit by students at more advanced levels in counselling or social work training and by experienced workers in key professions such as educational psychology.

PATRICK M. HUGHES.

HERRIOT, P. (1974). *Attributes of Memory*. London: Methuen, pp. x+205, p. £1·40, c. £3·25.

Herriot has produced an excellent up-to-date survey of research into human memory. This area of psychology began to attract the attention of considerable numbers of experimental psychologists in the late 1950s and early 1960s. Many researchers at that time, discontented with the over-simple associationist and interference notions constraining experimentation into verbal activities, saw promise in a newer structural approach that was influenced by modern developments in information-theory and computer technology. Human memory was regarded as a system of stores between which information was transmitted. A number of models which could be illustrated by flow diagrams were drawn up to describe the manner in which information was directed in a serial manner through the different parts of the memory system, culminating in a long-term store. Problems encountered in the use of computers served to remind experimental psychologists that for a memory system to function not only do items have to be stored adequately, but proper provision has to be made to ensure speedy retrieval when stored items are required. Research showing that a variety of parameters could influence the effectiveness of memory, and suggesting that verbal materials are not always stored in the same manner, seemed to confirm the belief that a number of separate human memory stores are required. Clinical evidence appeared to support this view, and the distinction between short- and long-term memory subsystems was widely accepted.

The most recent research indicates that such an account may be inadequate. The evidence suggests that whilst it is appropriate to speak of different levels of coding in memory, the assumption that information is serially processed and transmitted through a variety of separate stores is not justified. Herriot considers that the concept of levels of coding provides a necessary advance from approaches using information flow diagrams, and provides a better conceptual basis for research and theory. A variety of levels of coding in memory can be demonstrated by experimental research, and memory employs forms of coding which are appropriate to its various tasks. Some forms of coding are based upon or closely related to semantic and linguistic processes, and the close connections between memory and language are apparent in much of the evidence Herriot surveys.

The attribute approach adopted by Herriot is, he points out, merely a framework, not a theory generating predictions. Its function is to lead to the asking of useful experimental questions, rather than to point towards specific hypotheses. Herriot is not opposed to structural accounts of memory, and he admits that biologists have shown us how necessary it is to tie function to structure. However, he notes that it is dangerous to infer structure before we have any real idea how complex the functions may be. The models and flow diagrams that have been used to describe memory may represent premature attempts to understand memory structures. Before we do so, Herriot suggests, we need to collect a good deal more knowledge about the varied and complex attributes of memory.

Herriot writes well and clearly, and *Attributes of Memory* provides an admirable guide through the complexities of recent research into memory in humans. The emphasis on processes rather than structures does not add to the reader's ease of understanding, but the very careful pattern of organisation and the extensive use of sub-headings in this book help considerably. The author has provided a valuable survey of this important field of vigorous research activity.

MICHAEL J. A. HOWE.

KIRMAN, B., and BICKNELL, J. (1975). *Mental Handicap.* Edinburgh: Churchill Livingstone, pp. x+494, £15·00.

This is a curate's egg of a book. I use the term advisedly because I am sure the book is good in parts. It is also, in my opinion, very bad in parts. Following hard on the heels of the excellent third edition of Clarke and Clarke's *Mental Deficiency,* any new contender to the area would need to provide something different or more specific in its treatment of some aspects of mental subnormality, or perhaps even something simpler as a basic introduction to a difficult but by now well researched and documented area. All these things the present volume, an extended and much revised edition of Hilliard and Kirman's (1957) *Mental Deficiency,* both succeeds and fails in doing.

We are informed in the frontispiece that the book offers a multi-disciplinary approach to the rapidly developing field of mental handicap, which summarises recent advances and sets out advice in a practical manner for psychiatrists, school medical officers, paediatricians, general practitioners, social workers and teachers. Psychologists are not mentioned—it is probably just as well since the chapter on psychological assessment is one of the worst in the book. Jack Tizard, in his eulogising foreword, strongly supports the notion of presenting " specialisation in the round " and suggests that the group team approach, taken here by people most of whom work in the same hospital setting, should make it easier for different specialists in this area to understand each other's thinking. The editors themselves also point out that various sections are dealt with at differing levels of complexity.

Such an aim may well seem, at first sight, highly commendable. It is only when one comes to study in detail the relative contributions of the various authors concerned, however, that one begins to realise that rather than strengthen the book as a whole, such diversity does much to undermine it.

To start on a positive note, it seems to me that John Foley's chapter on neurological examination is a classic example of an expert leading us on a tortuous path through a highly complex and difficult area without ever ' writing down ' to his readers or assuming so high a level of initial understanding of neurological terminology that one is baffled or constantly needing to refer to a medical dictionary. Moreover, the conclusions he draws, although in many ways negative, leave this reader with both a sense of hope and greater understanding about just what neurology does and does not have to offer in this field. There is, for example, a clear but extremely detailed discussion as to why no satisfactory correlation has yet been established between pathological findings and neurological signs. This leads the author to make the extremely helpful suggestion that " the aim of examination in the subnormal should not be classification, a description of syndromes or a guess at aetiology but the analysis of signs in terms of *functional deficit* " (my italic). Unfortunately, this is one of the rarer occasions in this book on which the concept of functional deficit is given any real consideration.

At the other end of the scale, the chapter on psychological assessment by Elspeth Stephen and Jean Robertson, is not only largely out of date, but also extremely superficial. There is an abundance of recent first-class research evidence, e.g., collected in Mittler's *Assessment for Learning in the Mentally Handicapped,* in support of the move away from both nomothetic and medical disease models of psychological functioning in the assessment of the mentally handicapped. The trend has been on the one hand more towards a consideration of individual cases by means of a functional analysis of developmental strengths and weaknesses and, on the other, towards considering the development of handicapped individuals in themselves, rather than, say, in comparison with their more normal counterparts. It has become clear that to compare the results obtained by the mentally handicapped on tests devised for and standardised on normal groups is of extremely limited value when the need is for concrete advice or prescriptive programmes for action. It seems remarkable, therefore, that when so much of Mary Woodward's early work was carried out at the Fountain Hospital and so many potential avenues for exploration made available by this, that she is afforded little more than passing mention in a chapter which devotes so much to a consideration of the IQ and of the WISC and other tests. It is not that the authors do not mention other possible approaches, but rather that they convey a complete lack of conviction for any one approach and even fall back on ' personal communication ' from Tizard in justifying their consideration of *ad hoc* developmental scales. As a psychologist, I gained nothing from this chapter; I cannot begin to imagine what a general practitioner or social worker would gain from it.

The book ranges throughout between these extremes. It would be expected from someone with Brian Kirman's vast experience that the section on clinical aspects is thorough, detailed and slightly overwhelming. Neil O'Connor presents a first-rate psychological analysis of brain function in mental handicap that stands perfectly beside Foley's neurological analysis and David Norris and Paul Williams offer some interesting observations on the purpose and function of education for the mentally handicapped, but the chapters on physiotherapy and counselling are, in very different ways, so superficial that one wonders just for whom they were written.

Taken as a whole, then, this is not a very satisfactory book, particularly in view of the price. There are some good things to be found in it, though, and a large proportion of the references are up-to-date. The printing and illustrations are excellent throughout.

R. L. BURDEN.

LAMBERT, R. (1975). *The Chance of a Lifetime?* London: Weidenfeld and Nicolson, pp. ix+423, £7·00.

This is an important book because it succeeds in getting beyond the common stereotypes of boarding education and presents a comprehensive view of the different types of residential provision which exist outside the special schools. In doing so it presents a picture which is fascinating yet balanced, which at times amuses, at times saddens, which raises questions that are political and psychological. It moves in its final chapters from the objective to the personal as the author describes his attempts to relate the implications of his research findings to a particular school setting, and in doing so suggests creative possibilities for boarding as an educational approach.

The book describes the results of a study of 66 schools during the period 1964-8. All of the schools were for boys or co-educational, catered for the secondary age group and had achieved recognition from the Ministry of Education. The sample comprised schools from the Headmasters' Conference list (the public schools), progressive schools, independent schools and schools run by local education authorities. Seven of the schools were studied in greater depth over a period of at least half a term. All the remaining schools were visited for shorter periods of two weeks or more. The research approach embraced a variety of techniques which included interviews of selected people (headmasters, head boys, etc.), questionnaires and rating scales, analyses of documentary material (diaries, files, etc.), direct observation and living in by the researchers.

Having given a description of the broad characteristics of the schools and distinguished the relationships between boarding schools and wider society, the book proceeds to explore the varied goals of the schools. Three central aims, instrumental, expressive, organisational, emerge, each being given different emphasis and appearing in different patterns among the schools. Schools emphasising each of these aims are then examined in detail and contrasted. The author then attempts to assess the effects of boarding on the individual child and the family. These emerge as ' surprisingly sparse and tentative ' and include: few differences in academic performance between boarders and day-school pupils; no clear evidence of increased self-reliance among boarders; a tendency for boarders to value social rather than individual characteristics of people; a relationship between the age at which boys leave home and " their approach to others in their handling of emotions and authority figures and their sexual lives."

This book gives new dimensions to an area which hitherto has been viewed in rather uniform fashion. It brings light to an aspect of education which merits more attention from the applied psychologist as well as from the researcher and one for which creative educational possibilities exist. It presents a thorough and fascinating piece of research in an area which does not lend itself readily to research activity. In short, here is a book that raises many questions and excites new ideas, even though it ends on a ' somewhat pessimistic note.' It is difficult not to share this emotion when one reads of the headmaster who defines the parent as " a nuisance created by the motor-car."

ALEX E. JACKSON.

LOVE, L. R., and KASWAN, J. W. (1974). *Troubled Children: Their Families, Schools and Treatments.* New York: Wiley, pp. 314, £8·50.

This is a report of ten years of research on children with problems, carried out in Los Angeles. Part I examines the family and school backgrounds of children seen as ' disturbed ' by elementary school teachers, while Part II describes the development, application and evaluation of a ' self-help ' intervention programme, called ' Information Feedback,' involving the significant adults in the child's daily life.

The book begins well by stressing the need to reassess the value of clinical techniques traditionally used with disturbed children and to explore new ways of increasing the awareness of adults of their own role in the causation of problem behaviour. It is good to see fathers as well as mothers, and school factors as well as home influences, regarded as important. As the authors point out, few systematic studies have been made of the interaction between child and school personnel, or of the relation between the child's behaviour in school and home. The work described here has certainly been carried out systematically, and this report is comprehensive and well organised. It provides case material of interest and useful ideas on techniques for those attempting experimental work in the field covered. The difficulties encountered in the course of the research are discussed frankly, a specific section being devoted to " limitations, qualifications and ' wrong turns in the maze '."

However, in spite of these considerable merits, the book fails to sustain interest, mainly because of its often tortuous style, its tendency to repetitiveness and excessive attention to detail. In Part I, in spite of the build-up, little new emerges in the findings, and in any case, one can have little confidence in generalisations based on the kind of sample studied. The control group of ' normal ' children was small (N=29) as compared with the very heterogeneous experimental group of ' disturbed ' children (N=91). Further, the selection of schools on the basis of socio-economic level resulted in ' automatic ethnic separation,' with children from ' high ' and ' middle ' socio-economic levels being all white, and those from ' low ' socio-economic levels being all black. Since many comparisons are made on the basis of socio-economic background, this ' ethnic separation ' is a great pity, especially as the numbers in the different sub-groups are very small.

In Part II, ' Information Feedback,' which emphasised the importance of adults obtaining information about their role in determining children's behaviour through their own observation rather than through interpretations or suggestions offered by a clinician, was compared with two other more traditional treatment approaches—child psychotherapy and parent counselling. Much trouble was taken over the design of the experiment, but a serious weakness is that the referral categories were not distributed evenly among the different treatments: for example, ' aggressiveness ' was under-represented among children receiving Information Feedback, whereas ' hyperactivity ' and ' poor attention control ' were over-represented. Further, in view of the eclectic nature of much clinical treatment, it is doubtful whether a comparison between the three treatments is more than a highly artificial one. Nevertheless, the principles underlying 'Information Feedback' and the techniques it employs, are worthy of attention.

This is a very difficult book to evaluate, but it seems safe to say that it is likely to be useful to experienced research workers able to study it critically rather than to a wider readership.

MAURICE CHAZAN.

MEHRABIAN, A., and KSIONZKY, S. (1974). *A Theory of Affiliation*. Lexington, Mass.: D. C. Heath, pp. xvi+212, £7·30.

The authors argue that "affiliation is the most important aspect of social interaction." However, for all the importance of the concept, Mehrabian and Ksionzky claim that findings relevant to it have not been placed within a coherent framework. This volume, then, has been written to attempt to remedy this situation by the development of a tentative framework to organise such findings.

This framework is built in five stages: first, a preliminary stage of theory construction. Here the authors review and integrate findings and measures available in the area of affiliation and the related field of conformity. There is no initial definition of affiliation; in so far as one emerges at all, it is a definition in terms of the positive and negative reinforcements of certain observable features of interpersonal relations. An interpretation of this review of the literature may lead us to understand that by 'affiliation' is meant (briefly) an attitude and approach to others that is characterised by outgoingness, friendliness, and a readiness to establish relationships based upon equality, and relatively free of fear and anxiety.

The second and third stages are concerned with the development of measures relating to major theoretical constructs, and experimental methods for testing various hypotheses. The measures were intended for the study of (1) the generalised expectations of others' positive reinforcing qualities; and (2) corresponding negative expectations. Further attempts were made to define and measure affiliation by employing audio and visual recordings of the social interactions in a waiting situation (literally: conditions simulating waiting and reception rooms were created). The recordings were scored with the aid of two dozen measures of verbal and non-verbal cues which "had been identified in earlier studies using a diversity of methodology as being significant and meaningful parts of interpersonal communication."

The fourth stage is the description of the experiments themselves. The subjects were students of the University of California. A certain degree of what the authors describe as 'manipulation' was employed in these experiments in which subjects were surreptitiously observed through one-way mirrors. In such a way the reactions of strangers to one another in a waiting situation—not dissimilar to meeting strangers in a railway carriage—were studied.

The final stage is the evaluation and modification of the preliminary theory. Findings related to affiliation, dependency and conformity. The authors conclude that most of the results can be integrated and future ones anticipated within a reinforcement view of social interaction. They also suggest that clinical application of affiliation theory is in the selection of paraprofessionals in therapy, or where a leader is required for a small group which must work co-operatively.

B. SHAW.

NIELSEN, G. E. (1974). *Helping Children Behave: A Handbook of Applied Learning Principles.* Chicago: Nelson-Hall, pp. x+170, $8·95.

POTEET, J. A. (1974). *Behaviour Modification: A Practical Guide for Teachers.* London: Univ. of London Press, pp. viii+104, £1·25.

The last year or two has seen a veritable flood of publications—textbooks, guides and manuals—on the theory and practice of behaviour modification. Most have been written in the USA and this means, for the British reader, a sometimes awkward translation of American child-rearing and educational values and norms into British home and classroom settings. Fortunately, the two books reviewed here make the trans-Atlantic journey in readable and unforced style.

Nielsen's book is described as an abbreviated and simplified textbook of applied learning principles orientated towards children's problems. It is written for parents and teachers in particular and has the advantage over many other handbooks of not treating the child as if he were an empty organism. The author admits that behavioural theorists have been criticised, and rightly so, because of their apparent neglect of concepts such as communication, love and understanding. Their culpability in this is particularly serious as such concepts are, in fact, among the main reinforcers and source of motivation in our lives.

The book is made up of four substantial chapters: Principles: the basic learning models; Applying the learning models; Communicating with children; and Case Studies. The text is refreshingly concise and uncluttered by academic neologisms or turgid rambling sentences. The examples taken from home and classroom settings are practical ones and illustrate the various techniques of producing behavioural change. Chapter 3 is a particularly interesting one as it offers a reinterpretation in learning terms of Haim Ginott's widely read advice about decoding children's communications. In Nielsen's view most parents talk too much and communicate too little. He believes that when learning principles are correctly applied to behaviour problems in children, the process of long-term change in behaviour comes about because the parent learns to communicate with greater love and understanding and with fewer punitive measures. This belief may be a bit utopian but the more modest aim of the book of ' helping children behave ' will doubtless be fulfilled in the hands of the sensible parent, teacher or therapist.

Poteet's book is more specialised and in the words of the author " was not written to be quickly skimmed in a few hours." The use of behaviour modification should appeal to many teachers since in this model all behaviour is viewed as normal and does not seem to involve a basic alteration in the purpose of education, that is to say, for the teacher to attempt to modify those behaviours that interfere with the student's learning or the learning of his classmates. The techniques themselves are easy to learn. Poteet provides many examples of classroom situations in which the techniques can be applied. He also has some pertinent criticisms to make of those who think of behaviour modification as a panacea. The book contains five chapters: Describing behaviour; Measuring behaviour; Understanding behaviour; Modifying behaviour; and Evaluating behaviour. As the subtitle suggests, the book emphasises the practical applications of learning theory. Other texts will have to be consulted to obtain a deeper understanding of theories of learning. In all, this book provides useful and stimulating material for any introductory course dealing with the use of behaviour modification in educational settings.

MARTIN HERBERT.

PIAGET, J., and INHELDER, B. (1975). *The Origin of the Idea of Chance in Children.* London: Routledge and Kegan Paul, pp. xviii+249, £5·25.

Reviewing the present volume is rather like studying the stars. What we see has taken a long time to reach us. In the present case 24 years have elapsed between the first French edition and the present English translation. Since this work is a necessary complement to *The Child's Conception of Number* (1952), the time lapse is all the more surprising for such a readable work.

The Origin of the Idea of Chance deals with the question of how thought, in the process of formation, acts to assimilate those aspects of experience which cannot be assimilated deductively, e.g., the fortuitous or the randomly mixed. In seeking an answer Piaget and his co-workers investigated three aspects of the question: firstly, chance in physical reality (i.e., random mixtures, normal curves and uniform distributions, and constant relationship); secondly, the random drawing of lots (games of heads and tails, the random drawing of pairs, and the quantification of probabilities) ; and finally, combinatoric operations (e.g., putting piles of counters upon a table and asking the child to construct as many pairs as possible, not repeating himself with already chosen colours). The net result of this investigation was the constant emergence, in the three areas investigated, of three successive periods of development corresponding closely with those found in the evolution of logical—arithmetical and combinatoric operations. These three periods were captioned by Piaget, in their order of emergence, as: failure to differentiate between the possible and the necessary (certain); discovery of chance as a non-composable reality as an antithesis of operations; and probabilistic composition, a synthesis of chance and the deductive operations.

During the first period (up to C.A. 7–8 years), the child does not distinguish the possible from the necessary because he lacks the notion of necessity inherent in operative deduction. There is thus no conception of chance or probability. Random mixtures are expected to revert back to some hidden, pre-mixture order, based on the common properties of the elements. Alternatively, when it is a question of predicting isolated fortuitous cases, the reactions of the children are not based simply on resemblances, initial order, etc., but also on a conception of 'compensation,' i.e., " each one gets his turn." For example, if there are two eventualities (A and B) and A appears more frequently, the child will then bet on B because it has been skipped until then. In essence, the principal characteristics of this period constitute a homogeneous whole, accounted for by the dominance of immediate activity and the virtual absence of a co-ordination of the actions in reversible operations.

The second period (C.A. 7–8 to 11–12 years) marks the first development of the idea of chance. This period contains the development of two complementary mental achievements: operations are now reversible and composable in well-defined groups; and chance acquires a meaning as a non-composable and irreversible reality antithetical to these operations. The indetermination which now characterises chance implies that the possible and the necessary have become dissociated, but the child can only utilise this distinction intuitively, by analogy with the concrete operations which bear on the actual situation. The limitation of this period, in contrast to that of the third period, can be illustrated with the ' law of large numbers.' The child in the second period can grasp the ' law of small large numbers,' i.e., the role of numbers in small aggregates, but cannot generalise this for true large numbers because of the lack of formal combinations. This limitation reflects the child's mental dependence on data which are visible or representable in detail. The ' law of true large numbers,' on the other hand, requires the facility to operate on concrete operations by means of abstract thought.

Commencing around 11 or 12 years of age, the judgment of probability becomes organised in its general aspects by a kind of rebounding of operations on chance. Through the ' law of true large numbers ' the child comes to conceive of a distribution which becomes proportionally more regular and, consequently, understandable in its totality as a rational prediction. The child's individual evolution of the idea of chance is thus achieved, and probabilities based on large numbers indicate a kind of synthesis between operations and the fortuitous.

Two final comments should be made. On the credit side, this study describes a number of ingenious experiments which could be repeated, with profit, in the mathematics room of any junior high or secondary school. On the debit side, there is the irritating absence of any details about the sample on which the study is based. For example, *Pire's (1958) study, while agreeing in general with Piaget's findings, would seem to suggest that general intelligence and sex are important variables in relation to the development of the idea of chance. Without such further studies the reader of the present work would be left with the impression that age alone was the only significant variable.

JAMES H. BAMBER.

*PIRE, G., (1958). Notion du hasard et developpement intellectuel. *Enfance*, 131-143.

RICHARDSON, E. (1975). *Authority and Organisation in the Secondary School.* London: Macmillan, pp. x+146, £2·25.

This book constitutes neither an extended or condensed version of Miss Richardson's earlier case study, *The Teacher, the School and the Task of Management,* which rapidly and justifiably established itself as a major contribution to our thinking about the management of innovation in schools. The earlier book, like most case studies, left the task of generalising to its readers. In this sequel Miss Richardson decides to have a go at this herself.

She claims the book is an attempt to generalise about the management of innovation in schools by drawing on both published material from the earlier study and additional material. In the introductory chapter she focuses the reader's attention on four problem areas for the management of change in secondary schools. They are :

(1) The uses of authority and power.
(2) Dichotomies reflected in staff views and attitudes, and school organisation. In particular that between curricula and pastoral concerns is given special attention.
(3) The choice between a non-hierarchical ' human relations ' approach and a hierarchical ' management ' approach to staff consultation.
(4) The role of the head teacher in increasingly complex school systems.

These problem areas form the agenda for the rest of the book. It should be noted that Miss Richardson's theoretical commitments largely determine the selection of these areas, rather than others, as problematic, as well as directing her search for solutions. Dichotomies such as the curriculum-pastoral split only take on significance in the light of the neo-Kleinian theory of ' splitting.' Similarly, the choice between the ' human relations ' and ' management ' approach becomes significant in the light of Rice's Open Systems theory of leadership as a boundary function. Miss Richardson's work can be unambiguously located within the Tavistock Institute tradition of human relations research.

These considerations raise a number of important methodological questions:

(1) To what extent is the researcher under an obligation to explicate systematically the theoretical framework used ?

Uncharacteristically, Miss Richardson appears to be reluctant to do this much. There are places where she begins to explain the theories she is using but the reader has to glean the book to fit all the pieces together. I wondered if she had succumbed to pressures to avoid too much theory lest her readers be ' put off.' If so, this is unfortunate, because rather than aiding understanding it will make the book difficult for the ' non-Tavi ' reader to grasp as a whole, as well as deny critical access to the arguments it contains. Drawing on my slight experience of the tradition Miss Richardson is working in I will, very briefly, try to set out the theoretical framework of the book as I understand it.

Open Systems theory is one explanatory framework for problems of institutional leadership. Its key concept is that of the psychological boundary across which persons, groups, and institutions relate to each other in the performance of their respective tasks. Leadership is the function of facilitating task performance by controlling transactions (inputs and outputs) across boundaries. The key concept of neo-Kleinian theory is that of ' splitting,' which explains why phenomena are perceived in terms of mutually exclusive bipolar categories, e.g., thought and action, progressive and traditional, cognitive and affective. According to the theory such rigid dichotomies allow people to escape ambivalence of feeling by suppressing one side of the ambivalence and projecting it elsewhere. For example, rather than reconcile curricula and pastoral concerns within a single task a teacher may project his pastoral concern onto other people by perceiving it as a separate task he has no responsibility for. It is not difficult to see how school organisation could reflect and reinforce this kind of ' splitting.'

Miss Richardson evidently believes that the theories of Open Systems and ' splitting ' are mutually supportive. Together they relate persons and roles. When the boundaries between roles reflect the personal alienation which results from ' splitting ' a person can only stay in role by denying part of himself. However, when boundaries provide individuals with opportunities for facing ambivalence they allow them to function as persons in their roles.

Miss Richardson's book constantly draws her readers' attention to some fairly typical ways in which she believes school organisation denies individuals opportunities of growing as persons through their role performances, and illustrates how her work with Nailsea teachers led to a redefinition of boundaries between roles and tasks in the school. In doing so it constitutes an important contribution to thinking about the relationship between authority and personal freedom in the management of innovation. However, the theoretical framework is highly normative because it implies a view about the nature of man. The validity of Miss Richardson's work ultimately rests on the adequacy of her theories. This is why I have argued that they should be systematically explicated. I am a supporter of the view that there can be no value-neutral theory of human relations, but this fact provides the researcher with good reasons for making the ideological foundations of the research accessible to critical scrutiny.

(2) To what extent should the researcher be eclectic in the use of theory to study educational situations?

Practical situations, like education, require eclectic treatment by utilising a variety of theories both within and across disciplines. In drawing almost exclusively on a particular set of theories Miss Richardson's work can only provide us at best with a partial view of the complex practical situations which form its subject matter. This limits the comprehensiveness of her generalisations. Nevertheless, inasmuch as they direct our attention to even partially significant factors for the management of innovation, they are worthwhile and important for practitioners to reflect on.

(3) Shouldn't practically orientated research illustrate an 'open' approach to the data so that we constantly sense a tension between theory and data?

Miss Richardson appears to squeeze the data into her theory at points where it could generate new theoretical categories if she were more open to the possibility of modifying and extending her own categories. I often felt that significant features of situations were being ignored because they ' did not fit.'

(4) What is the value of generalisation from a single case study?

The generalisations contained in this book could be of immense value to the teaching profession if they are viewed as hypotheses to guide practical deliberation in particular situations, rather than a set of validated claims which ought to be applied without question. Miss Richardson would, I think, want them to be viewed in this light. The worth of her generalisations partly resides in the extent to which they get practitioners monitoring their own and other people's decision-making regardless of whether such monitoring confirms or refutes their applicability in particular cases.

JOHN ELLIOTT.

ROSE, G., and MARSHALL, T. F. (1974). *Counselling and School Social Work.* Chichester: Wiley, pp. vi+347, £6·50.

There is a considerable literature dealing with the influence of either home or school on various aspects of a child's development, usually from the standpoint of a particular discipline, and the disadvantages which social workers can be under in attempted work with schools is frequently described. There have been remarkably few action-research studies of social work in a school setting, and for this reason this is an important book. Those which have been published previously have tended to be descriptions of work carried out as parts of relatively small-scale projects, but even so have brought additional and wider perspectives. The book under review gives details of a large-scale, long-term programme in Lancashire and for this second reason is an important book.

The action-research programme concerned the problems and results of the introduction of social workers and counsellors into five secondary schools, as a preventive service for pupils who might be considered maladjusted, and the effects which the injection of social workers has on school-community relationships. The social workers all had some experience of working with young people, and during their attachment took a full part in the life of the school, even doing occasional teaching. The researchers found that though teachers could easily identify withdrawn children, they tended to refer, initially, only those who were unruly in class. With time, the social worker's role became understood and teachers referred cases where family problems seemed to be affecting school work, and, later still, parents and children approached the social workers directly. As a result of their close contact with pupils, the social workers were often able to take action before trouble reached crisis point, particularly where the more disturbed children were concerned.

The effects of this action on the school organisation and on the 2,000 second and fourth year pupils were monitored rigorously, and resulted in a reduction of delinquency and social maladjustment. Two comparable schools in the area, without social workers, were studied for comparative purposes. At the outset of the programme the delinquency rate in both groups of schools was about the same, roughly 13 per cent. After three years the rate in the experimental schools was only three-quarters that of the control schools, and after five years this proportion was reduced to two-thirds. Such a measure charts only a behavioural change and the social workers themselves believed that an important objective was in improved social and personal adjustment. Overall, children in the experimental schools achieved a better social adjustment than those in the control schools—including those who were not at any time actually on the social worker's caseload.

The authors develop their thesis into a generalised discussion of the value of social work in a school setting, and the book contains chapters devoted to analysis of the school as a social system, the relationship between and specific contributions of teachers and social workers, and the administrative consequences.

The study will give a clear answer to the criticism that attaching social workers to secondary schools may seem a wasteful duplication of resources where there is coverage by statutory social work agencies. Much of the content of the book reflects the interests of researchers rather than of practising teachers, especially the section describing the research design, tests and other data, but should be regarded as part of the essential library of both groups.

A. GORTON.

SHELDRAKE, P., and BERRY, S. (1975). *Looking at Innovation: Two Approaches to Educational Research.* Slough: NFER, pp. 147, £3·10.

Since the title and sub-title give little indication of the contents, some clarification is necessary. Innovation refers to the introduction of background courses into vocational university courses, to wit, behavioural sciences for medical students and a background (or ' wider issues ') course for electrical engineering students. The two approaches were that, in the former case, the researcher deliberately intervened in the situation being analysed, while in the latter he attempted to have as little impact on the course as possible. Both these studies took place under the aegis of the Nuffield Foundation's Group for Research and Innovation and, more specifically, were part of the Anabas Project directed by Professor Liam Hudson.

The case study approach as used in this particular area has some irritating features. The individual case study takes a considerable amount of time and demands of the researcher a wide range of experience and expertise so that the reader feels unsatisfied on two counts—firstly, that two case studies are not enough to ' illuminate,' as they hope, " some of the issues that characterise the teaching of background courses." One wonders, for example, if the views of the students (and staff) were not peculiar to these universities or those particular courses—what might, say, civil engineers have felt? Then, one feels that the researchers took with them their preconceptions from their own experiences as (presumably) social science students and were unprepared for the formal structures of the situations they studied and for the reactions of students who had chosen such specifically vocational courses. Perhaps they were somewhat unprepared for realities of academic politics or, indeed, for the ways of working parties ? In other words, how would researchers with differing experience have interpreted the data?

Neither study, as the researchers say, was wholly successful, and neither were the courses. Both situations were ill-defined in the minds of staff and students with conflicting ideas of both the explicit and the implicit ideas of the courses. The styles of presentation of the two courses contributed to these difficulties and one feels that a study of a course which had been more successful might have given a more balanced view of the issues. It seems to the reviewer that there was not, because of this, a sufficient follow-up of the facts that, for both groups of students, there was felt a lack of contact between staff and students, and that there was an element of passive reception of facts on the part of the students. But the researchers were already attempting to analyse their data on several different levels so that these aspects of the relationship between staff and students and of the method in which the individual acquired knowledge were rather neglected.

In short this is an unsatisfying book which raises more questions than the data could possibly answer. Nevertheless, it should be studied by educational researchers both for the questions it raises and for the approaches used, making due allowance for the limitations of the case study approach.

JENNIFER STEWART.

STANLEY, J. C., KEATING, D. P., and FOX, L. H. (Eds.) (1975). *Mathematical Talent: Discovery, Description and Development.* London: John Hopkins, U.P., pp. xvii+215, £5·50.

The history of mathematics reveals many instances of quite exceptional mathematical talent associated with precocity. It is interesting to speculate on the effects of our modern educational system on a Pascal, a Leibnitz or a Gauss. Has emphasis on equality of opportunity led to too complete an equality of treatment, irrespective of aptitude ? Have the links made in the training of our teachers between the progression of mathematical concepts and the findings of developmental psychologists led to too much hesitancy in attempts to accelerate individual progress in mathematics?

Overcrowding teaching certificate, postgraduate diploma and B.Ed. schemes allow little time for the study of the exceptional child. Yet many newly validated courses are flexible enough to allow individual students to pursue studies linking mathematics and psychology in a chosen area, such as the education of the gifted. The text reviewed can be recommended for library purchase where students embark upon studies of this type and where more directly applicable texts, such as the Schools Council Research Study *Gifted Children in Primary Schools*, are already stocked. Research findings and discussion contained in nine separate papers stem from a five-year project on the study of mathematically and scientifically precocious youth, which began in 1971 at the John Hopkins University, Baltimore. The central notion, that of intervening in the educational process in order to foster precocious mathematical achievement, comes over with lessened impact to the British reader because of its expression in American terms with much emphasis on ' grade-skipping,' Algebras One and Two and doctorates in late adolescence. There is more of relevance to the British teacher in chapters on the history of work with the gifted, on their personality characteristics, values, sex differences, career choices and classroom behaviour and on appropriate educational counselling techniques.

With its microscopic approach, this book is useful in identifying areas of concern for those seeking to provide suitable individualised instructional materials. The researchers are fortunate in their access to a group of highly talented adolescents. Yet more problems remain than are solved. Who are to be the working companions of the very bright child? Instead of ' grade-skipping ' do we try giving Open University materials to exceptionally able 15-year-olds? What is to be the teacher's reaction to the gifted pupil who becomes interested in work to the exclusion of all else? Is the fostering of precocity always desirable anyway ?

ANNE TROWN.

WEIMER, W. B., and PALERMO, D. S. (Eds.) (1974). *Cognition and the Symbolic Processes*. Chichester: Wiley, pp. xii+450, £10·00.

This book reports the proceedings of a conference held at Pennsylvania State University in October, 1972. It takes as its point of departure " the current revolution in psycholinguistics and cognitive psychology " and 14 papers are presented in the areas of linguistics, perception, learning and neuropsychology. The meat of the book, however, is devoted to comprehension and meaning.

The symposium format is followed with papers on a theme being followed by a discussion. Unfortunately, for readers of this *Journal*, none of the articles deals with developmental aspects of cognitive psychology and the interest must, therefore, be in the theoretical arguments about the nature of knowledge, meaning and understanding. The book is, indeed, strong on theory and participants have been asked to keep data to a minimum.

The work divides roughly into five sections, of which the first two are somewhat divorced from the main theme of the conference. One is a somewhat laboured attack by Brewer on behaviour theory as an explanation for even simple behaviour along with a note on method by Dulaney. (In an overview chapter at the end, Weimer deals more effectively with the limitations of behaviourism). The other is a linguistic contribution by Ross and McCawley in which Ross offers ' Three batons for cognitive psychology.' The discussion indicates that his colleagues are reluctant to accept them and generative semantics does not seriously feature elsewhere in the volume.

At the opening of his chapter, Mace remarks: " On the face of it, James Gibson's approach to perception is not a likely candidate for concern in a volume devoted to problems in cognitive psychology." Whether one takes this view or not, by the end of the book a case for Gibson has been made. Nearly half of the contributors, and notably Mace, Turvey and Halwes, are at pains to relate the theory of ecological optics to cognition generally, and at times the book reads like a eulogy for Gibson. Much of the discussion centres around the relative merits of a constructive *versus* direct stimulus processing view of perception. Weimer, in his excellent overview, seems to settle the argument nicely: "All perception is a construction in the CNS, but it is a construction resulting from input that only Gibson and his students have specified intelligently."

Chapters by Bransford and McCarrell, Franks and Brewer deal with comprehension and meaning. Paivio and the imagers come under fire and they reject a word meaning approach for a higher level of analysis which takes into account object relations and a linguistic knowledge. It is surprising that the very relevant work on language development (e.g., Bloom, Huttenlocher, the Clarks) is ignored, since it might have led Bransford *et al.* to their conclusions rather earlier. This section represents a laudable attempt to do justice to the complexity of language comprehension, though it should be noted that other equally important dynamic aspects of the problem, such as the fact that communication is a social situation involving person perception and roles, are not considered.

A slightly disappointing piece by George Miller (according to his own high standards), offering a third metaphor (computation) for psycholinguistics, concludes the book save for Weimer's overview which could also be read with profit as an introduction.

This is a work bursting with ideas which may come to represent a landmark in the shift to a broader level of analysis in cognitive psychology. But for educationalists in the applied field its interest is limited.

PETER LLOYD.

YARROW, L. J., RUBENSTEIN, J. L., and PEDERSON, F. A. (1975). *Infant and Environment*: *Early Cognitive and Motivational Development*. New York: Halstead Press, pp. xviii+255, £8·65.

This monograph reports the effects of early experience on the behaviour of 41 five-month-old black infants from a poor quarter of Washington, D.C. Data were collected during six hours of observation in two home visits. In his foreword J. McV. Hunt claims that the correlation of " a broad variety of environmental variables with a broad variety of infant variables yields results relevant to nearly every controversy and issue in the domain of early experience." This is an exaggeration for this is in no sense a major work but an honest contribution to a field where studies using non-institutional children are few.

Among the host of relationships reported two can be picked out as surprising. It was unexpected that kinesthetic, rather than visual, auditory or tactual, stimulation should have the greatest influence on the wide range of behaviours measured. Another finding was that social mediation, by the mother, of the child's play with toys is a distracting rather than facilitating influence. This is in contrast to the importance that Bruner and others place on the mother's directional role in the child's interaction with its inanimate environment.

It is easy to get bogged down in the wealth of correlational data and so a chapter on case descriptions of six of the children is welcome. This highlights individual differences and shows that social class as a variable has nothing to say about the distinction between healthy and inadequate environments.

For British readers familiar with this field, the approach of Yarrow and his colleagues may appear dated. And, as if anxious to forestall criticism, they discuss some of the weaknesses of their unidirectional approach and suggest that an " ideal method of studying contingencies is through continuous recording of sequences of interaction between mother and infant." This is, of course, the approach of British workers such as Richards, Travarthen, Schaffer and the Newsons. It will be a pity, however, if this monograph is ignored since it demonstrates the necessary role played by the inanimate environment in early development—a factor sometimes forgotten in the socially-oriented accounts of British researchers. It also has scarcity value as one of the few large-scale studies of infants interacting in their own homes.

PETER LLOYD.

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SUMMARY. Two groups of 20 first-year students were asked to read three sections of a textbook. After the first two sections the groups received different types of question. One group received questions which demanded a thorough understanding of the meaning of the passage. The other group was given detailed factual questions. After the final section of reading a common set of questions of both types was asked. Besides providing further evidence of qualitative differences in learning, the experiment showed that students did adapt their way of learning to their conception of what was required of them.

INTRODUCTION

THE idea that the demands for recall anticipated after learning are crucial for the type of processing that subjects engage in during learning has long been recognised (cf. Marton, 1969, 1973a, 1973b; Anderson, 1970; McKenzie, 1973). This implies that the criteria used for evaluating learning can be conceived of not only as dependent variables but also as important independent variables which to a considerable extent determine the processes and outcomes of learning. Several empirical studies have been carried out to investigate the effects of type of test and type of questions on learning. Terry (1933), Silvey (1951), and Dahlgren *et al.*, (1974) all report that students subjectively experience that learning is affected by the type of test anticipated. The general result in studies of this kind has been that expecting an objective test leads to a more superficial level of processing i.e., focusing attention primarily on 'signs', often expressed by subjects as ' attending to details ', while expecting an essay or oral test is subjectively reported as leading to the focusing of attention on ' general principles and main points ', thus suggesting deeper processing.

While studies involving only subjective reports have mostly yielded fairly clear-cut results, indicating that the type of test expected affects the kind of processing that subjects engage in, those involving an assessment of actual differences in performances have produced a more diffuse picture. Meyer (1934, 1935) compared the influence of two different ' examination sets', requiring on the one hand recall (tests containing essay or completion questions) and on the other recognition (true-false or multiple-choice questions). He found that the type of test expected had a considerable impact on performance as measured by immediate as well as delayed testing. A ' recall set ', and particularly the anticipation of an essay test, led to higher performance except on immediate testing with recognition questions, and there are furthermore interesting parallels between subjective reports on level of processing and performance. Other studies, e.g., Vallance (1947), Hakstian (1971) have not corroborated these results.

Recently, several investigations have shown that questions interspersed with learning can have a considerable effect on the type of information to which people pay attention. Within research concerning ' mathemagenic ' activities a a vast number of studies have been carried out to clarify the effect of such questions on learning and the " . . . most intriguing single result from our work is that the character of questioning tends to shape the character of the knowledge which is acquired " (Rothkopf, 1968, p.127; cf. Rothkopf, 1972; Nelsson, 1973). Watts and Anderson (1971) show that repeated exposure to questions affects the type of processing that students engage in. When demands, as defined by questions given after studying short texts, became evident, students adapted their level of processing to the type of question expected. Marton (1975) carried out a study where an attempt was made to induce deep processing by inserting content-neutral questions (e.g., Can you summarise the content of each . . . subsection one in or two sentences?) after each section of a text. The results were somewhat unexpected in the sense that a control group, receiving no treatment, achieved a far better result on both types of criteria, questions and recall. It is furthermore interesting to note that the differences between groups persisted even after a two-month interval when a retention measurement was carried out. These quite dramatic differences in outcome can be attributed to the fact that, instead of using the inserted questions in the way intended, subjects made it an end in itself to answer these questions. This resulted in a very superficial level of processing, since learning merely became equivalent to identifying the information students knew they would require.
The author concludes:

> " The questions *via* which the requirements are defined . . . are only signs of or means to, the real intended requirements, i.e., the acquisition of knowledge in the sense of competence. There are no limited sets of questions however, which define competence. When subjects interpret the signs of intended requirements in such a way that they are identical to the intended requirements, they technify and narrow the task and make it trivial ". (Marton, 1975).

Most studies on the problem of the effect of the demands of anticipated questions on learning have worked with quantitative criteria of learning, in the sense that the number of correct answers achieved by different groups have been compared. However, as Marton and Säljö (1976) point out, the concept of level of processing and the assumption of a functional relationship between level of processing and level of outcome calls for a description of level of outcome which is commensurate with the description of level of processing. In other words, the criterion must be sensitive to qualitative variations in outcome, since level of processing implies variation in a qualitative rather than in a quantitative dimension. To some extent this demand has been met in studies using questions from different levels in, for example, Bloom's (1956) taxonomy, although the classification in these cases primarily refers to characteristics of the questions *per se* rather than to characteristics in outcome of learning. Furthermore, and perhaps even more important, in the present study the description of qualitative differences in outcome refers to differences in the conception of a certain topic treated in the text, while in studies using taxonomical hierarchies knowledge at a higher level is usually *different* from knowledge at a lower level as far as content is concerned. This is reflected in the fact that different questions are used to measure knowledge at different levels. In our case, the description of qualitative differences in outcome refers to differences in how students answered the *same* question or recalled the same topic.

In the present study the aim was two-fold: to apply the model of description of qualitative differences in learning and to induce alternative levels of processing and levels of outcome through the demand characteristics imposed on students by the nature of the questions interspersed with learning.

According to the conception of learning elaborated by Marton and Säljö (1976), the object of a person's attention during learning can be conceived of as varying in a qualitative dimension, being either on the surface of the discourse (the text *per se* or the sign) or on the intentional content of the discourse (what is signified by the sign). The independent variable in this study, intended to induce different levels of processing, was the nature of the questions put to subjects after reading. By giving questions which could be answered only if subjects paid very close attention to information in the surface structure of the text, and by making this demand highly predictable through repeated exposure to such questions, it was hoped that surface-level processing could be induced. Thus, we wanted to impose on one group of students (SL-group) a conception of learning which was essentially reproductive, i.e., learning was to be equivalent to being able to recall more or less exactly what was said in the texts. Another group of subjects were exposed to questions which aimed at inducing deep-level processing (DL-group). These questions were constructed with the specific aim of testing whether the subjects had comprehended some of the more fundamental assumptions and conclusions in the author's argument.

METHOD

Sample. Forty female first-termers at the University of Gothenburg served as paid subjects and were randomly assigned to one of the experimental conditions in groups of 20.

Procedure. The students received no instructions in advance as to what they were expected to learn from the text (three incomplete chapters, containing 2113, 3850, and 3279 words respectively, from Coombs: *The World Educational Crisis*: *A Systems Analysis*, Swedish edition, 1971). Instead they were told to read the three chapters and be prepared to answer some questions on the content after reading each of them. Thus, the only clues available to subjects as to how to behave was the nature of the questions they received after the first two chapters. (Examples of the two different types of questions are given in the Appendix). Besides being exposed to questions aimed at inducing deep-level processing, the DL-group were required to recall the chapter just read and to state the main points in it in a few sentences as a part of the experimental manipulation. The number of questions given to the SL-group after the first two texts was five and to the DL-group three, though there were some follow-up questions making the total number of questions given to both groups somewhat higher. (The DL-group were given fewer questions because of the extra work required of them as part of the experimental manipulation).

After reading the third chapter, both groups were required to recall and to summarise the main points in it in a few sentences as well as answer questions intended to measure surface-level and deep-level aspects of the content. (Examples of questions are again given in the Appendix). A semi-structured interview was also conducted to gather introspective data on the effect of the experimental manipulation on level of processing. Finally a retention measurement was carried out after approximately 45 days; all subjects were again given all the questions.

If, on the immediate measurement, students could not answer a particular question or gave an inadequate answer, they were provided with the correct one by the experimenter. The questioning after the third chapter as well as on the retention measurement was carried out by an experimenter ignorant of which experimental condition students had been exposed to. All session were conducted orally and recorded on tape and were later, for purposes of analysis, transcribed. All categorisations and classifications of subjects were carried out by two independent judges according to judgment instructions constructed by the authors.

RESULTS AND DISCUSSION

Description of Outcome of Learning

Both the recalls (on immediate measurement) and the questions were analysed with the specific aim of detecting qualitative differences in outcome. The different conceptions of the various topics that appeared in recall or were inherent in answers to questions, were found to be classifiable as separate categories of comprehension or, to use an alternative expression, as different levels of outcome. The different levels of outcome found in relation to a certain topic or question could then be aggregated to constitute an outcome space for that particular topic or question (cf. Marton and Säljö, 1976).

Since the most important aspect of research on learning, according to this view, is that learning must be described in terms of its content, the author's own discussion of the main points must first be summarised.

The author's meaning

In the third chapter the author discusses two alternative school admissions systems, the ' selective ' and the ' open ' system respectively. In the former only a certain proportion of a year's pupils is accepted, while in the latter case the individual pupil can, for example decide whether to go on to high school or to leave the school system.

In this connection the author also discusses problems that occur, both generally and in specific cases, when the pass rate (i.e., the relative proportion of students entering the school system who subsequently leave it with a completed exam) becomes too low. However, in the passages used in this experiment the relationship between the type of admissions system and the pass rate is never made explicit. This particular section in Coombs' argument provides an ideal illustration of the qualitative differences in learning which occurred. In analysing data of this type it is, of course, impossible to present detailed analyses of every part of the passage being read by the students. Only illustrative analyses can be provided, although additional material has already been published (Säljö, 1975).

Answers to specific questions

To check whether subjects had understood the very fundamental differences mentioned above, between the two systems in relation to the pass rate achieved, one of the questions asked why the ' selective ' system tends to have a higher pass rate. Excluding those subjects who could not answer this question (categorised 'O'), there were four different levels of outcome or ways of explaining why the selective system has a higher pass rate. The basic structure of these different levels is presented below, together with an example of one of the answers classified at each level.

A *The instrument of selection is chosen to predict the chance of success*
" Because the criteria of selection are often constructed in such a way that people who get through the selection tests . . . the entrance exams, they get through what comes afterwards too."

B *Only the ' best ' students are admitted*
" Because they've made certain of getting the elite."

C *More students pass in this kind of system*
(no causal explanation given).
" Well, this was the system that most people managed to get through. With open system there were a lot of drop-outs."

D *Only those students who are strongly motivated apply/being in a ' selective ' system leads to higher motivation*
" Only people who are really interested apply."

Three of these levels, A, B, and C, can be regarded as hierarchically related in the sense that the higher levels include the lower ones in terms of the amount of information contained. The A level answers are very precise and indicate a fundamental understanding of the way a ' selective ' system of the type discussed in the text actually works. The B level answers are less precise since they merely refer to the fact that the ' best ' students are accepted without explaining in what sense they are best. However, the B level answers are wholly adequate in relation to the question asked. The C level answers are very low on information and may indicate a superficial level of processing. In fact, if we examine them carefully we find that they are merely restatements of what is said in the question. It is, however, interesting to note that some of these answers represent a fairly exact recall of a part of the passage where the author discusses the differences in ' drop-out ' rate.

The D level answers, focusing upon motivational aspects, are in another dimension and thus cannot be said to be hierarchically related to the other levels. Undoubtedly these answers are better than those at the C level, since they contain a possible, and partially true, explanation of the differences in pass rate between the two systems, but this motivational aspect is not discussed in the text.

TABLE 1

" *Why does the Selective System as a rule have a Higher Pass Rate ?* "

Relationships Between Level of Outcome on First and Second Occasions.

		Second Occasion					Sub-Total
Level		A	B	C	D	O	
First Occasion	A	1	2				3
	B		9	1	3	2	15
	C		2	1	1		4
	D		3		2	1	6
	O		2		2	5	9
Sub-Totals		1	18	2	8	8	37*

* The values of three subjects are missing. Owing to an oversight on the part of the experimenter this question was not given to two subjects while the third did not take part in the delayed measurement.

Table 1 shows the distribution of subjects on the different levels on the immediate as well as on the delayed measurement. From the table we can note a remarkable stability in the answers. Actually there is a considerable variation in the words used by subjects to express their answers on the two occasions, but the basic structure of the answer given on the immediate measurement is in almost 50 per cent of the cases, including those categorised as O, repeated after a 45-day interval. We also note that the fact that subjects were given a B level explanation has had some effect, since seven subjects who gave a lower level answer on the immediate measurement moved to the B level on the delayed measurement. On most of the questions which were qualitatively analysed the general result, as concerns the differences between the answers on the two occasions, is that either the answers contain the same basic structure on both occasions, or the answer given at the second measurement is more inexact and fragmentary thus being classified as belonging to a lower level. This general finding supports those reported by Marton and Säljö (1976), where forgetting could be described in terms of a move from a deeper towards a less deep level.

Qualitative differences in recall

The description of qualitative differences in recall was a very complicated undertaking. There was an enormous variation in the surface structure of the recalls and there was also a considerable variation in length, from 0 to 850 words. In order to be able to deal with this somewhat chaotic heterogeneity, the text was divided into nine different topics which were used in the quantitative assessment of the extent to which subjects covered the main contents of the text in their recalls. On four of these topics a qualitative analysis was carried out and we shall restrict our discussion to one of these.

One of the main themes of the third chapter was the ' drop-out ' problem, and its individual and social consequences were described fairly fully by the author. 27 students in one way or another touched upon this topic in their recalls and three different levels of outcome are discernible. We shall present the basic structure of these levels together with an example of each.

A The first category of subjects were *conclusion-oriented* in their comments on this topic, in the sense that they included the most important aspect of the discussion concerning the ' drop-out ' problem in their recalls, namely causes or consequences of the problem and the conclusions that can be drawn. One of the seven students (out of the 27 who included this topic) who answered at this level expressed herself as follows:

> "... in countries like Africa, well, developing countries, where a lot of pupils drop out after the third or even the first grade, there's not much pressure on the higher levels ... and in the developing countries they look at things so much from the point of view of sex roles. It's usually girls who drop out and in rural districts it's also been pointed out that there are more drop-outs and it may be that cultural and economic factors ... (are decisive) and it may be ... well ... just dreary teaching ..."

B The next level consists of students who more or less fully *described* what the author said about the ' drop-out ' problem without including causes, consequences or conclusions. Nine students were categorised as belonging to this level on this particular topic.

> " It was about drop-outs in the USA and in various developing countries ... in the USA, for example, more people drop-out at secondary education and in the developing countries the number who drop out at the primary stage is very large."

C The last category of students treated this topic only very superficially and they merely *mentioned* that the author had discussed this topic. 11 students were classified on this level.

" It was about drop-outs and failures . . ."

The description of qualitative differences in recall exemplified here follows the same hierarchical model as the description of the answers to the questions. The *conclusion-oriented* utterances contain at least a part of the intentional content of the author's treatment of a certain topic, i.e., the causes or consequences and conclusions the author wants to extract and point out in his discussion. Level A thus implies level B, which only contains a description of a state of fact, and level C, finally, contains no information at all about what was said concerning this particular topic.

EXPERIMENTAL EFFECTS

Subjective reports on the effect of questions under different experimental conditions

The subjective reports indicate that the demand characteristics imposed on subjects through the interspersed questions had a considerable impact on level of processing. In the group who were given factual questions (SL) this impact was quite uniform, in the sense that subjects reported that they paid very close attention to the surface structure of the text, e.g., to lists of points and figures. For some subjects this was evidently quite in line with their usual conception (or definition) of learning, while others had to modify their regular learning strategy in order to fulfil the requirements as they experienced them. This is illustrated by the following two quotations from subjects in the SL-group:

"E: What did you think of the questions? Did you think they were easy or difficult?

S: I thought they were good, anyway. At least on the first two sections. I thought they were more or less what you might expect to be asked."

"E: What did you think of the questions? Were they easy or difficult?

S: Well, I got a shock. There were only two questions I could answer on the first bit and there was . . . All the rest was sort of detailed about figures and I wasn't in the least prepared for that sort of thing."

"E: The second and third time, how did you manage on the detailed questions then?

S: Well, then of course I'd . . . then I was more prepared for them so I tried to learn the stuff I expected to come up."

In the group for which the questions required a deeper understanding (DL) the influence of the experimental manipulation was less uniform and basically two modes of coping with the requirements were identified. One category of students used the predictability of the demands of the forthcoming tasks to develop an algorithm for learning, focusing primarily upon being able to recall the text and summarise the main idea in it in one or two sentences. Judging from the subjective data, the demands imposed on this category of subjects through the ' deep ' questions were too vague, in the sense that subjects did not realise that they needed to undertake deep processing. The consequence was that they ' technified ' learning trying to fulfil only the most explicit demand —the recalling and summarising the text in one or two sentences.

"E: When you read this third piece, were you influenced by the questions you'd been asked on the previous pieces? Did you think about what you would . . .?

S: Well yes, I did a bit. I thought about learning . . . that I was going to make a summary, but that was about all really."

"E: What did you think of the questions? Were they of the type you had expected?

S: Well, I don't know. I'd thought that they'd possibly be a bit more clear-cut: What was that? and so on.

E: Hmm.

S: They were sort of . . . not general . . . but a bit more on the content in general."

As we shall illustrate later, the recalls resulting from this interpretation of the demands are very low on information, containing almost exclusively—superficial *mention* of the various problems dealt with in the text.

The other mode of coping with the requirements was more in line with the intentions behind the experimental manipulation, using the predictability of the coming demands as a reason for adopting a certain type of processing.

"E: When you read this third text, were you influenced by the questions you had had previously and, as it were, of what you had experienced?

S: Yes, I was. I must admit that I was.

E: In what way was that?

S: It helped me.

E: Hmm. For example, when you read the first piece and then you went on to read the second. Did you think while you were reading the second piece that you could more or less predict what questions would come up?

S: Yes, more or less.

E: I see. So you made use of the previous questions to . . .

S: Yes, I did.

E: I see.

S: But I got some help too as to *how* to read the piece. The questions you asked me put me on to a good way of reading the piece somehow.

E: How do you mean?

S: Well, it's just that . . . When I read through a passage. I think it's difficult to know . . . what am I really trying to get out of this, what am I supposed to read, what am I supposed to learn?

E: Hmm.

S: So the first questions I got, in the first piece, taught me somehow to think about what was actually most important in what I was reading."

It is interesting to note, however, that some subjects in this category had a negative definition of the demands, in the sense that they realised what type of information they would not be tested on, but they were somewhat vaguer as regards what type of information they had actually focused on during learning.

Qualitative differences in recall under different experimental conditions

Differences in performance, corresponding to the subjectively reported data concerning level of processing, are readily found in recalls as well as in answers to questions. Comparing the two experimental conditions, we find a marked difference in how close to the surface structure of the original text subjects recall the text and answer questions. Consider for instance the following passage from the third text and the excerpts from recalls of two subjects in each group.

> " Another common source of difficulty is the imbalance between the output of sub-professionals and full professionals in associated fields. The proper ratio may differ by countries and by fields, yet it is still a universal problem. If the trained professional is to be fully productive, he must be backed by sufficient para-professionals and technicians who can perform appropriate supporting tasks. Guy Hunter suggests that the optimum ratio of technicians to university graduate specialists is between 3: 1 and 5: 1, depending on the country and the subject. Against this norm, he and other investigators have found that in many developing countries this ratio is often 2: 1 at best and sometimes only 1: 2. In these circumstances full professionals end up doing the tasks which sub-professionals should be doing.
>
> A good example of this is provided by Chile, in the field of health, where an investigator reports three doctors for each nurse, in contrast to Sweden's ratio of five nurses for every two doctors and the United States ratio of seven nurses for two doctors. To make matters worse, the number of nurses graduating in Chile has recently been about half the number of doctors," (Coombs, 1968, pp.77-78).

RESPONSES FROM THE SL-GROUP

> "... then there was the ratio of professionals to sub-professionals, someone or other had said that the ratio should be between 3-1 and 5-1, that is a trained professional should have 3-5 assistants but usually it was about 2-1 or at worst 1-2 and there they compared Chile, Sweden and the USA. In Chile there were 3 doctors to one nurse, in Sweden 5 nurses to 2 doctors, and in the USA 7 nurses to 2 doctors, and anyway it was worst in Chile, because a lot of nurses emigrated to America when they had done their training, because there was still a shortage of nurses there."
>
> "... and then there were examples from ... there was some American expert who had stated that the ratio of technicians to professionals should be roughly between 3–1 and 5–1, which in the developing countries was at best 2–1 and at worst 1–2, and there were some examples that in Chile there were 3 doctors to one nurse, in Sweden 5 nurses to 2 doctors and in the USA it was 7 to 2 and even so somehow that nurses in Chile often emigrate to the the USA because the pay is better there."

As can be noted there is a striking similarity between the original version and these recalls. The subjects in the DL-group on the other hand treated this topic from a more general point of view in most cases, as can be seen from the following excerpts:

RESPONSES FROM THE DL-GROUP

> " And then there are problems in various areas, that is the pace at which professionals are trained in a certain area must bear a relation to, have a certain relationship to the training of less qualified staff in the same area That is, a professional must have a largish number of technicians under him

> otherwise he'll have to do the work himself, that is the whole thing is wrong."
>
> ". . . and then they say that on the whole it's like that in various countries that these, what shall I say, the ratio of qualified to less qualified people is sort of the wrong ratio, that is there aren't enough assistants to researchers and so on, sort of, so researchers have to do the sort of jobs they, well, so they haven't got time for what they're really supposed to be doing, 'cos they've got to do a whole lot of other things and so on."

Significant between-group differences on immediate as well as delayed measurement have been found in the responses to the questions, (Säljö, 1975), but here the discussion will be limited to some interesting aspects of the learning process illustrated in the present study.

First as we have shown, the *between-group* differences point to the clear modifiability and context dependence of a person's conception of learning. In other words, learning seems to be defined differently depending on, for instance, anticipated task demands. The same observation can be made if we look at the results obtained *within* the DL-group. As we pointed out earlier, the subjective reports indicate that students in this group interpreted the demand characteristics differently. Some subjects focused attention primarily on the recall question, resulting in recalls which were virtually devoid of detailed information, although still often comprehensive, in the sense that subjects *mentioned* many of the topics which the author dealt with.

Consider, for example the following quotations which are the complete recalls of two subjects in the DL-group:

> " Well, it was about drop-outs and failures, about various admissions systems, and the need of certain types of education, and future prospects."
>
> " It was about the end-product of education roughly. How it can affect society afterwards. They mentioned drop-outs and failures in various countries . . . in the developing countries compared with the industrialised countries . . . more or less . . . how the future looks."

These examples illustrate how learning can be ' technified ' when task demands become predictable. Learning under these circumstances runs the risk of being reduced to a search for the type of knowledge expected on the test (cf. Marton, 1975). If the type of learning depends (as it does here) upon the type of evaluation anticipated, what is learned will undoubtedly reflect what is seen to be appropriate for that particular purpose, although by other criteria it would be considered very poor. With the type of evaluation used in many educational contexts there is a great danger that the importance of rather trivial aspects of learning will be over-emphasised. As Miller and Parlett (1974) have shown, the ' cue-seeker ' who is more aware of what is required of him in examinations, is also likely to be more successful.

The second interesting point emerging from this study relates to the students' normal conception of learning. What type of material did they pay attention to in the first passage, before being exposed to the experimental manipulation? This question can be answered by looking at responses of the SL-group after reading the first chapter.

Here the author discusses various aspects of unbalanced growth in different fields of society and in this connection he makes five general propositions:

> " If population grows faster than food production, each year there will be less available on the average for each person to eat. If the educational system grows faster than the Gross National Product, and it has been doing

> so for some time, it will sooner or later have to slow its growth until the economy catches up. If the educational system turns out graduates faster than the economy can give them jobs, unemployment among the educated will increase. If the child population expands faster than the educational system can absorb them and give them a decent education, there will be either a lower partcipation rate than desired or overcrowded schools of poor quality. If *all* these critical rates of growth—economic, agricultural, demographic, and educational—get seriously out of balance, the nation's whole development process will be in trouble, not merely economically, but socially and politically," (Coombs, 1968, pp. 25–26).

A question relating to these propositions was given after the subjects of the SL-group had read the first text:

> "*Can you repeat the author's five statements about the relationship between growth and development?*"

The prime intention behind this question was to induce surface processing, in the sense of making subjects focus attention on listing information, irrespective of whether it could be considered as important or not. However, it soon became obvious that this kind of material was very much in line with what subjects had actually expected to be tested on. This is evident from the subjective data from both groups (the students in the DL-group saying that this was the type of question they had expected instead of the ones they actually received) as well as from the fact that the subjects in the SL-group remembered on an average 2·75 of these propositions immediately after having read the text. Thus, it seems that for many subjects an instruction to read a text like the present one is interpreted as requiring the reproduction of lists of this kind. For long-term retention, this interpretation of what is required seems to be very unfortunate. On retest 45 days later these students were only able to recall 0·2 of the propositions, while a much higher level of retention was found for the more fundamental aspects of the passage (Säljö, 1975; Dahlgren, 1975).

The same detrimental effects on long-term retention can be shown when the superficial conception of learning (or level of processing) was experimentally induced. It has been shown elsewhere (Säljö, 1975) that this type of processing covaries with relatively high performance on immediate testing of knowledge from the surface structure of a text. As regards long-term retention, however, the picture seems to be completely different, in that subjects who were being manipulated towards deep-level processing show a higher level of retention even on the type of material on which, for immediate testing, superficial processing seems to be efficient. With this type of knowledge there thus seems to be a possibility that what is learned may in fact differ even when the outcome is identical.

The fundamental importance of recognising the necessary link between the level of processing adopted by the student and the level of understanding reached cannot be overstated. Students adopt an approach determined by their expectations of what is required of them. While many students are apparently capable of using 'deep' or 'surface' strategies, it may be that the current demands of the examination system at school level are interpreted by them as requiring mainly the recall of factual information to the detriment of a deeper level of understanding. The present investigation suggest that students may need to refocus their attention on the underlying meaning of what they are required to study and that this process could be helped by ensuring that the assessment procedures demand deep-level processing. However the existence of the group of students who 'technified' their attempts at deep-level processing indicate that a more prolonged, and perhaps more explicit, redirection of attention may be necessary. Even then it may be that different strategies of learning remain, reflecting an important aspect of individual differences about which all too little is still known.

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APPENDIX

Examples of questions aimed at including surface-level processing (given to SL-group after chapters 1 and 2).

(1) According to the author there are three reasons for the general increase in demand for education. Can you recall these?

(2) According to the author the shortage of teachers depends on three factors. Which three?

(3) What is the approximate male/female proportion in the teaching profession at the primary and secondary school level in Great Britain? At the primary school level in Austria?

Examples of questions aimed at inducing deep-level processing (given to DL-group after chapters 1 and 2).

(1) PUPIL INPUT IN DIFFERENT PARTS OF THE WORLD (1950=100).

	Primary school		Secondary school		Higher Education	
Area Year	1960	1963	1960	1963	1960	1963
Africa	223	273	271	364	267	345
Europe	114	119	160	186	161	211
Latin America	175	203	227	325	203	262
North America	142	153	161	192	157	197
Southern Asia	175	204	213	267	240	273
Whole world	140	157	172	210	179	230

Look at this table and answer the following questions:

(*a*) What can one learn from this table and what do the figures signify?

(*b*) Why are the figures for Africa, Latin America and South Asia higher than those of Europe and North America?

(*c*) Which level of education has increased most rapidly?

(*d*) What is meant by 1950=100?

(2) What is meant by " . . . educational demand, feeding on itself, creates its own dynamic "?

(3) Could you explain the meaning of the folllowing quotation: " . . . too many poor teachers will drive good ones out of the market "?

Examples of questions given after chapter 3 to all subjects.

(1) (*a*) What is meant by the term ' output of education '?
 (*b*) What is the simplest way of measuring the output?

(2) What is the approximate percentage studying agriculture at an academic level in the developing countries?

(3) The drop-out problem during primary education is a difficult problem for most developing countries. Which categories of children are most likely to drop-out at this early stage? Why just these children?

(4) What problem could the developing countries run into if they suddenly were able to cope with the drop-out problem at primary education?

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STYLES AND STRATEGIES OF LEARNING

BY G. PASK

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SUMMARY. Previous results are reviewed and two series of experiments on learning are described, one carried out in the laboratory, and the other in educational institutions. Both series use 'conversational' systems which allow mental activities to be described in terms of dialogue and behaviour. Several types of result are reported: (*a*) the significance of understanding; (*b*) the existence of, and variations in, learning strategies; (*c*) the effect of matching and mismatching a teaching strategy to an individual's learning strategy; (*d*) the nature and classification of cognitive style; and (*e*) transfer effects and 'learning to learn.' A theoretical basis is developed for a classification of learning styles.

PREVIOUS WORK USING CONVERSATIONAL TECHNIQUES

AN earlier paper (Pask, 1976) introduced conversational techniques, some involving a human participant in dialogue with a student, others involving a mechanically or computer implemented 'participant' through which the student 'talks to himself' under restrictions imposed by the device. In either case (human or mechanical monitoring) the subject matter of a conversation is represented in a liberally conceived, but standard, fashion, as a *conversational domain* consisting in an *entailment structure* (embodying one or more description schemes and indicating the many ways in which one topic may be known in terms of or derived from others) and *behaviour graphs* (one for each topic in the domain) that prescribe what may be done to model or explain the topic in question. Within this framework, the conversational techniques secure, or approximate, a standard condition for experiments on learning. If a topic is learned then it is, in a technical sense, *understood.* The requirement that 'learning a topic' means 'understanding a topic' is as strong as, or stronger than, a requirement for 'depth processing' as described earlier in the symposium by Marton and Säljö (1976).

Analysis and justification of the understanding requirement led to psychological postulates; for example, that a *concept* is a procedure for realising a topic relation and a *memory* is a procedure for reproducing a concept. The entire framework of postulates is specially tailored to accommodate educationally realistic learning and allows the formulation of hypotheses about style, learning strategies, teaching strategies, generalisation, retention and the like, which can be tested within the *standard condition* (see Pask, 1976) of a conversational system. The verified interlocking hypotheses are an interpretation of 'conversation theory,' (Pask, 1975a, 1975b). Some predictions have already been tested, using the conversational system as an experimental paradigm. Later and ongoing experiments, based upon similar predictions, are described in this paper.

Earlier studies of learning and teaching using conversational techniques uncovered several consistent tendencies. The main findings of previous studies are summarised below and their statistical significance is reported in Table 1.

TABLE 1

SUMMARY OF PREVIOUS FINDINGS ON CONVERSATION LEARNING.

<table>
<tr><th rowspan="2"></th><th colspan="6">Retention Test Scores</th><th rowspan="2">Significance</th></tr>
<tr><th colspan="3">Effective Teachback</th><th colspan="3">Ineffective Teachback</th></tr>
<tr><td>(I) Students classified as holist and serialist on 'Taxonomy' task.</td><td colspan="3">Mean 28·5 (Max. 30)
SD=1·0 N=8</td><td colspan="3">Mean=16·1 (max. 30)
SD=3·4 N=8</td><td>Effective>Ineffective
P<0·01
Mann-Whitney U test.</td></tr>
<tr><td rowspan="2">(II) Students instructed in matched and mismatched conditions by programmed test for approximately 1½ hours.</td><td colspan="3">Matched</td><td colspan="3">Mismatched</td><td rowspan="2">Matched>mismatched
P<0·001
Mann-Whitney U test.</td></tr>
<tr><td colspan="3">Mean=29·5 (max 30)
SD=0·3 N·8</td><td colspan="3">Mean=13·7 (max. 30)
SD=3·8 N=8</td></tr>
<tr><td rowspan="2">(III) Students classified as holist and serialist, learning (probability theory) on CASTE under fixed teaching strategy for approximately 8 hours.</td><td colspan="3">Matched</td><td colspan="3">Mismatched</td><td rowspan="2">Matched>mismatched
P<0·001
Mann Whitney U test.</td></tr>
<tr><td colspan="3">Mean=61 (max. 100)
SD=4·8 N=8</td><td colspan="3">Mean=31·5 (max. 100)
SD=6·1 N=8</td></tr>
<tr><td rowspan="2">(IV) Students learning probability theory on CASTE under three different conditions of learning. (Matched condition as in III)</td><td colspan="2">Free learning</td><td colspan="2">Matched strategy</td><td colspan="2">Uncertainty Regulation</td><td rowspan="2">Uncertainty regulation>
Free learning P<0·001
Uncertainty regulation>
Matched strategy
P<0·001.
Mann Whitney U test.</td></tr>
<tr><td colspan="2">Mean=52·2%
SD=25·6
N=10</td><td colspan="2">Mean=61%
SD=4·8
N=8</td><td colspan="2">Mean=96%
SD=5·6
N=10</td></tr>
<tr><td rowspan="3">(V) Students learning probability theory on CASTE, uncertainty regulation and free learning. Change in average uncertainty per topic (ΔH).</td><td colspan="3">Transfer</td><td colspan="3">Data</td><td rowspan="3">1st half>2nd half
P<0·05
Mann Whitney U test.</td></tr>
<tr><td colspan="3">1st part of learning</td><td colspan="3">2nd part of learning</td></tr>
<tr><td colspan="3">MeanΔH=0·97
SD=0·49 N=20</td><td colspan="3">MeanΔH=0·22
SD=0·23 N=20</td></tr>
<tr><td>(VI) Change in average value correct belief per topic ($\Delta\theta$).</td><td colspan="3">Mean$\Delta\theta$=−0·72
SD=−0·22 N=20</td><td colspan="3">Mean$\Delta\theta$=0·22
SD=−0·06 N=20</td><td>2nd half>1st half
P<0·005
Mann Whitney U test.</td></tr>
</table>

(1) Concepts of topics that are *understood* in the strong sense of the first paper (i.e., for which the learner has given an explanation and a derivation) are, in fact, stable. Not only are the concepts protected from interference whilst learning is confined to one conversational domain, they are also reliably retained, as judged by post-tests after two weeks or more which emphasise explanatory recall.

(2) In a conversational system, whether humanly or mechanically instrumented, students are forced to make explicit their learning strategy, because of the understanding requirement. Under these conditions learning strategies are polarised into mutually exclusive classes which have been termed *holist* and *serialist*. Having adopted one kind of strategy the student does not relinquish it (even though he cannot successfully execute it) unless strong advice is provided or he learns about a different domain where he can start afresh. Sharp strategic distinctions occur because students become locked into one strategy to the exclusion of others, a phenomenon similar to Festinger's (1957) 'cognitive dissonance'.

If learning is controlled in the way described in the previous paper (e.g., the CASTE or INTUITION systems), the holist and serialist strategy classes can be characterised by potentially independent empirical criteria.

The *holist* has many goals and working topics under his aim topic; the *serialist* has one goal and working topic, which may *be* the aim topic. Holist strategies are shown in Figure 1 in which each frame represents the understanding of one topic. Evidence suggests that the holist is assimilating information from many topics in order to learn the ' aim ' topic, while the serialist moves on to another topic only when he is completely certain about the one he is currently studying.

There is ample evidence that holist students entertain beliefs (often correct beliefs) about topics other than the working topics or the aim, while serialists have little or no idea about other topics. Holists thus tend to discover a global description of topics, or to invent a description compatible with the conversational domain, while serialists only describe the topic for which they are constructing an explanatory model.

Under ' teachback ' conditions (where verbal explanations are elicited) a finer, though less objective, discrimination is possible by content analysis of the spoken utterances. Holist students ask questions about broad relations and form hypotheses about generalisations. Serialists ask questions about much narrower relations and their hypotheses are specific. Amongst the holists, some (*redundant holists*) invent description schemes of their own. *Irredundant holists* still use many descriptors but these are relevant and coherent.

The following illustrations are drawn from a conversational domain concerned with an imaginary species of animal (the Gandlemuller) and its behaviour, feeding habits, anatomy, and so on. They are typical of these different learning strategies.

Serialist . . . " Gandlers have no sprong " or, the interrogative forms " Do Gandlers have sprongs ?" or " Which kind of Gandlemuller has no sprongs . . .?"

Holist . . . " There are more kinds of Gandler with mounds (dorsal or cranial) than Plongers " or, the interrogative form " Are there more kinds of . . ?"

Redundant Holist . . . " The ones that were discovered first are gentle; the other kinds, the aggressive beasts found later, well they are the ones with less mounds."

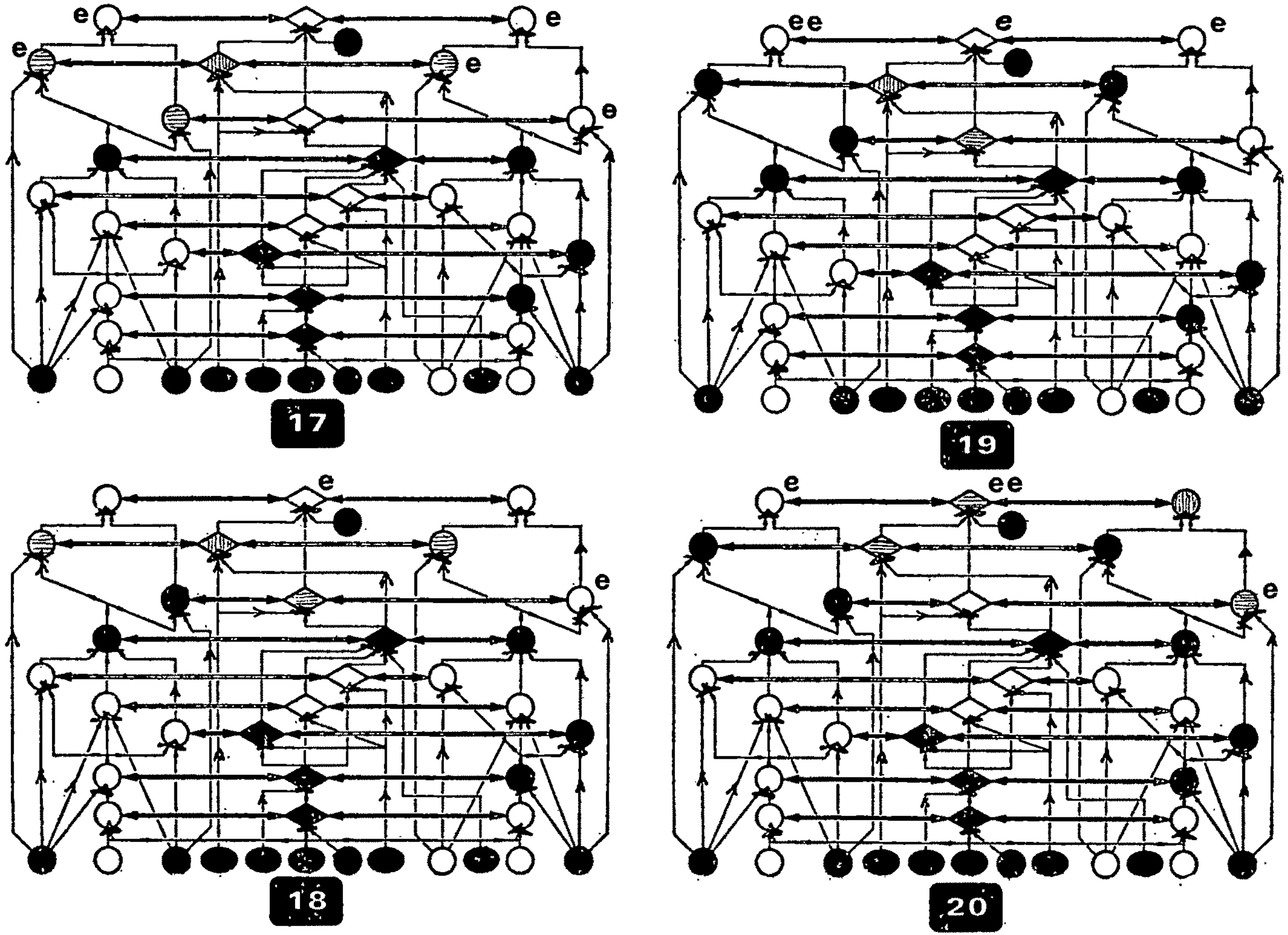

FIGURE 1

4 Frames depicting state marker distributions over 4 consecutive occasions (N=17, 18, 19, 20) in a typical holist learning strategy. Topics are represented by the circular ' O ' nodes, analogical topics by the diamond shaped '◇' nodes. States are indicated by shading as follows : *Understood*= ■; *Goal*= ▤; *Aim*= ▥. Explore transactions are shown as ' e ' marks at the periphery of the nodes explored. This student entered the entailment structure by 'explain and derive ' transactions, some of which are situated at a considerable distance from the lowermost ' primitive ' topics and such a behaviour is typical of some holists and some serialists. Whereas the holist typically has several *goals* and an *aim* ahead of them, the serialist learning strategy is typified by one *goal* at once, the *goal* topic often coalescing with the *aim* topic. Serialists usually rely less upon analogy relations, and are prone to cluster their *explore* transactions at the start of learning rather than continuing with exploration throughout the process.

In fact, neither order of discovery nor gentleness appear as data in the conversational domain. Both predicates are invented, but later they acquire meaning and serve as adequate *personal* discriminators which assist in describing real differences.

(3) Since the holist/serialist classes can be specified within the theoretical framework of the earlier paper (Pask, 1976), it is also possible to distinguish teaching strategies which belong to one class or another. A teaching strategy may be embodied in programmed texts, lectures, or books, or alternatively it may be built into a regulator such as a teaching machine.

(4) Normally students receive subject matter presented in only one particular way, yet they consistently prefer a particular type of learning strategy, when given a choice. If the teaching strategy is matched to the same type of learning style (e.g., holist/serialist), the student will learn more quickly and retain the information for longer. Conversely a mismatched condition leads to grossly inferior performance and a pronounced failure to comprehend the principles underlying the subject matter.

(5) If learning takes place in a controlled system (CASTE or INTUITION) the disparity between matched/mismatched instruction is dramatic. Mismatched students acquire hardly any relevant knowledge. Performance over a group is enhanced if the tutorial system is designed to achieve matched conditions by ' learning ' about the individual student and recommending matched procedures which also retain the student's level of uncertainty within limits.

(6) An incidental finding is that competence in using a strategy does not always go alongside disposition to adopt it. Some students are disposed to adopt a strategy they cannot use effectively enough to satisfy the understanding criterion. As a rule, these students feel they ' ought ' to adopt a serial approach. There is a strong institutional bias to structure material in this manner and most examinations favour serial recall. These individuals cannot learn subjects at a ' deep level ' (Marton and Säljö, 1976) unless they are introduced to, and employ, a holist strategy. The converse disbalance (students who feel they ought to take a global view but are adept serialists is less common,but has been observed).

THE PRESENT STUDY

Introduction

The hard core of evidence on learning style is due to Bruner *et al.* (1956), Guilford (1956), Kagan (1965) (the impulsive/reflective distinction) and Witkin *et al.* (1975) (field dependence/independence). There is a body of more recent work which includes work by Thomas (1971), on reading style; Dirkzwager (1974) on style in logical problem solving; Klix (1971) on concept acquisition; Tversky and Kahneman (1974), and Strub and Levit (1974) on decision style; Hankins (1974) on styles exhibited by engineering design students; and Elshout and Elshout (1969) on styles of creative reasoning. Protocol investigations by Newell and Simon (1972) on thinking, and Landa's (1974) experiments on logic and language learning, clearly exhibit distinct styles. Other studies include Bree (1974), Allen (1974) and about one fifth of the papers contributed to a conference on ' Structural Learning ' (Scandura, 1974). The *notion* of style, in contrast to its empirical demonstration, goes back to antiquity (see, for example, Yates, 1966). Moreover, differences in style can reliably be detected outside the laboratory, most dramatically, perhaps in the way people explore, learn about, and perceive their environment (Lynch, 1960; Glanville, 1974).

The ' holist/serialist ' distinction (Daniel, 1975; Pask and Scott, 1971, 1972) is an example of different learning *strategies*, rather than the more generally exhibited learning style. The holist or serialist strategies are exhibited in a ' strict conversation,' and are thus insufficiently refined to account for learning in general. Holism and serialism appear to be extreme manifestations of more fundamental processes, which are induced by systematic enforcement of the requirement for understanding which is as strong as, or stronger than, the requirement for ' deep-level ' processing (Marton and Säljö, 1976). If the strict understanding condition is relaxed, as it is in class tuition or self-study, some students are disposed to act ' like holists ' (*comprehension* learners) and others ' like serialists ' (*operation* learners), with more or less success. There are also students able to act in either way, depending upon the subject matter, and if they excel in both pursuits, we refer to those students as *versatile*. It is these distinctions which can, more appropriately be referred to as learning style.

The gist of this comprehension/operation distinction is as follows: comprehension learners readily pick up an overall picture of the subject matter, for example, redundancies in a taxonomic scheme or relations between distinguished classes and recognise clearly where information can be obtained. These individuals are able to build descriptions of topics and to describe the relation between topics. Their cognitive repertoire includes effective, though individually distinctive, description building operations, although such learners may not be able to apply these operations to specific subject matter information (for example, to classify specimens) until the procedures underlying the concepts in question are specifically taught.

Left to their own devices, operation learners pick up rules, methods and details, but are often unaware of how or why they fit together. They have, at most, a sparse mental picture of the material and their recall of the way they originally learned is guided by arbitrary number schemes or accidental features of the presentation. On the other hand if an operation learner is provided with a specific description (by external means) he assimilates procedures and builds concepts for isolated topics. His cognitive repertoire includes accessible or effective *procedure building* operations.

Whereas holist and serialist strategies belong to distinct classes (because of the restrictions imposed by the apparatus), it is emphasised that the comprehension/operation learning distinction is a matter of *degree*. The point is important because it can be shown, on empirically supported theoretical grounds, that *both* description building and procedure building operations are prerequisites for understanding any topic. In the experiments which are described below it is necessary to identify in advance students likely to adopt serialist or holist strategies within the conversational systems. Students can be so classified either by a trial run through a conversational domain, or by using an appropriate test designed to assess biases towards operation learning, comprehension or versatility. (Such a test, the ' Spy Ring History ' test, is described later). It is then possible to assign students to materials which are designed for the same (matched condition) or for the opposite (mismatched condition) learning style.

FIRST SERIES OF EXPERIMENTS

Methods

The first series of experiments was carried out to replicate and extend some of the main findings already described, using a larger sample of students, slightly less restrictive circumstances and much more varied subject matter. The design (Figure 2) involves a *Free Learning* condition using a semi-mechanised arrangement for recording and display. Students are free to aim for topics and to explore topics (obtaining information about topics by slide projection) and they are free to work on topics provided on information cards which they can cluster together (similar to, but not identical with, working upon several goals in the CASTE or INTUITION system). The understanding condition is not enforced, but students must adopt some learning strategy and the few who failed to do so (less than 10 per cent of the original sample) were rejected. All transactions had to be accompanied by a statement of intention or purpose within the classification headings of Table 2. An on-line index of success is obtained and the experimenter is thus able to persuade students to adopt a strategy they are competent to execute.

Another condition in the design is *Teachback* (noted in the previous paper, as one method of securing *understanding* and, at least, deep level, processing). The teachback condition is balanced by dummy or ' ineffective teachback ' in which, though the administrative ritual is similar, the demand for understanding is replaced by meeting a less stringent correct response criterion. Students also learn from a programmed text designed according to holist and serialist teaching strategies and are periodically pre- and post-tested. The subject matters employed for style-assignment (comprehension, operation, versatile) and for learning were the two taxonomies of imaginary animals ('Gandlemullers' and ' Clobbits ') used in earlier studies (Pask and Scott, 1972), two biological subjects (the operon and the menstrual cycle) and an inductive inference task (Tech. Rep., 1973). All of these were prepared as conversational domains in the way described in the previous paper.

Sample

The experimental design is shown in Figure 2. The sample consisted of 62 students from two polytechnics sub-divided into two groups. The first group of 32 students was asked to work through the ' Clobbit ' taxonomy Free Learning task and each student was then classified as tending towards comprehension or towards operation learning. With an interval of approximately two weeks, subjects returned first to work through the ' Gandlemuller ' taxonomy task in either a 'matched' or a 'mismatched' condition, and then to tackle the operon cycle task in a ' matched ' or ' mismatched ' condition. Teachback protocols, indicating learning strategies, were elicited for all tasks completed on earlier sessions, and retention tests were given each time a student returned for further sessions. Different subgroups received either ' effective ' or ' ineffective ' teachback.

The second group of 30 students was treated similarly, but, for them, the free-learning task was the menstrual cycle and the two programmed text tasks were the operon cycle and probabilistic inference. All students in both groups returned later for a final session of retention tests and teachback. As shown in Figure 2 the distribution of matched/mismatched instruction and effective/ineffective teachback are balanced by alternation within the strategic classification and within groups. Each session lasted from five to six hours, so that the complete experiment occupied between 20 to 24 hours for each student.

Results

The most discriminating ' objectively scorable ' indices of learning style are the ' intentions ' underlying each free learning transaction, the mean number of data cards clustered for working on under one aim topic, and the student's correct certainty (θ) and uncertainty (H) about topics addressed and those lying ahead of their current aim topic (H^*, θ^*) (Table 2). A less discriminating prediction is obtained from the frequency of repetitious explorations and the extent to which immediate ' teachback ' order recapitulates the order in which items are addressed during ' free learning.'

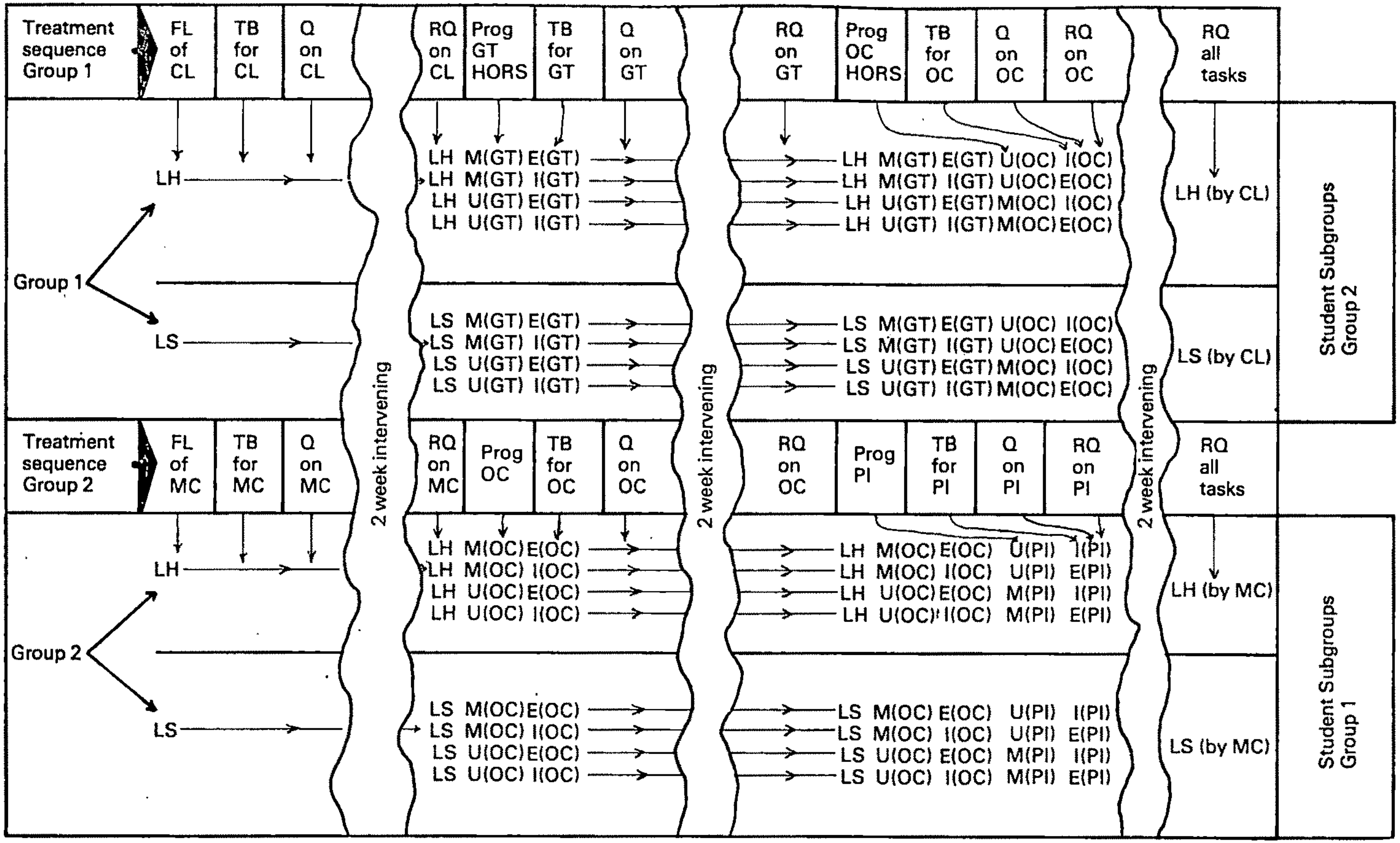

FIGURE 2

Experimental Design. Note: the design receives a balanced combination of matched (M) and mismatched (U) instruction and of effective (E) and ineffective (I) teachback (TB), for students classified as (comprehension learners like holist—LH) or (operation learners, like serialists—LS) after free learning (FL). Different initial subject matters (the Clobbits taxonomy CL and a menstrual cycle MC) other abbreviations are GT for Gandlemuller Taxonomy OC for Operon Cycle and PI for probabilistic inference. Q means ‘ Questions Test ’ (including explanatory questions) and ‘ TQ ’ is test questionnaire for long term recall.

TABLE 2

SUMMARY OF DATA FROM FREE LEARNING SESSION.

Student Group		Frequency of Intention types						Mean No. of cards/ cluster	Uncertainty and Correct Belief			
		I	II	III	IV	V	VI		H	θ	H*	θ^*
Group 1 Operation learners .... (N=18)	Mean ..	1·6	2·8	9·3	3·5	2·2	0·2	1·74	1·29	0·38	0·71	0·06
	SD	1·7	1·9	5·3	1·9	2·5	0·03	0·36	0·80	0·31	0·87	0·28
Group 1 Comprehension learners (N=14)	Mean ..	1·2	1·4	3·9	7·9	3·8	3·7	2·95	1·19	−0·05	1·32	0·28
	SD	0·5	0·8	3·4	1·8	1·1	0·42	0·42	0·60	0·40	0·42	0·66
Group 2 Operation learners .... (N=17)	Mean ..	1·7	2·4	8·6	1·4	1·9	0·3	1·72	1·09	0·37	0·43	0·36
	SD	1·0	1·3	1·9	1·0	1·5	0·5	0·30	0·68	0·21	6·47	0·32
Group 2 Comprehension learners (N=13)	Mean ..	1·8	2·6	2·8	8·6	2·0	3·6	2·98	1·34	0·30	1·76	0·38
	SD	1·0	1·2	1·7	2·0	0·9	1·0	0·36	0·89	0·26	0·64	0·32

Statistical summary:

1. Frequency of intention classes IV and VI: comprehension learners>operation learners ($P<0{\cdot}001$).
2. Mean No. of cards/cluster: comprehension learners>operation learners ($P<0{\cdot}001$).
3. Operation learners have significantly higher means for θ($P<0{\cdot}01$).
4. Comprehension learners provided values for H* and θ^* on significantly more occasions ($P<0{\cdot}01$). (All comparisons by Mann-Whitney U-test).

Key Intention types:
I=exploratory perusal of cards.
II=general search for information.
III=looking for a particular piece of information.
IV=looking for several pieces of information.
V=testing a single predicate hypothesis.
VI=testing a mult-predicate hypothesis.

Uncertainty and Correct Belief:
H=Uncertainty.
H*=Look Ahead Uncertainty.
θ—Correct Belief.
θ^*=Look Ahead Correct Belief.

Apart from the original assignment, retrospective determination of style was carried out in those phases of the design (Figure 2) devoted to ' teachback ', using a content analysis of the tape-recorded 'teachback' protocols. This assessment of style was based upon the conversational domain for the subject matter in question, using six statement types; falsehoods; inventions; requests for information; deductions; irrelevant statements; and redundant statements. Judged by the Mann-Whitney U-test the frequency of inventions, requests, and deductions for the comprehension (holist–like) learning groups is greater than the frequency amongst the corresponding operation (serialist–like) learning groups (in each case $P < \cdot 001$); Irrelevant and redundant statements are more frequent amongst mismatched than matched operation learners ($P < \cdot 001$) and as might be expected, mismatched students utter more falsehoods than matched students ($P < \cdot 001$).

The influence of matched/mismatched instruction was determined by questionnaire retention tests and Table 3 shows percentage scores on the relevant tests. The influence of effective/ineffective teachback (understanding required or merely a correct response criterion) was determined by comparing pre-teachback and post-teachback scores (Table 4). Both ' matching/mismatching ' and ' understanding/no necessary understanding ' conditions influence both the stylistic and the teachback data in ways that are best understood by examining the lengthy tabulations obtained for individual students. These tabulations are available on request, or in Tech. Rep., 1973, but the data has had to be summarised for publication here.

TABLE 3

SUMMARY OF RESULTS FOR STUDY OF EFFECTS OF MATCHING/MISMATCHING.

Student Group	Condition	Matched with Gandlemuller programme	Mismatched with Gandlemuller programme	Matched with Operon programme	Mismatched with Operon programme
Group 1 Operation learners	Mean	90·9	33·0	90·8	34·9
	SD	3·7 (N=9)	8·4 (N=9)	3·8 (N=9)	6·1 (N=9)
Group 1 Comprehension learners	Mean	91·0	45·6	47·0	90·0
	SD	3·6 (N=7)	5·4 (N=7)	6·3 (N=7)	1·8 (N=7)
Student Group	Condition	Matched with Operon programme	Mismatched with Operon programme	Matched with Probabilistic Inference programme	Mismatched with Probabilistic Inference programme
Group 2 Operation learners	Mean	92·0	35·3	98·0	32·8
	SD	3·7 (N=9)	8·8 (N=8)	20·1 (N=8)	9·8 (N=9)
Group 2 Comprehension learners	Mean	92·9	38·8	93·7	43·0
	SD	4·0 (N=7)	8·0 (N=6)	3·4 (N=6)	11·1 (N=7)

Statistical summary:

1. Each student's matched performance> mismatched performance ($P<0{\cdot}001$, Wilcoxon Matched Pairs signed ranks test).
2. Aggregate difference: matched task scores>mismatched task scores ($P<0{\cdot}001$, Mann-Whitney U-test).

TABLE 4

Summary of Results for Study of Retention Using Effective and Ineffective Teachback.

Student Group		Effective teachback on Gandlemuller Programme	Ineffective teachback on Operon Programme
Group 1 Operation learners .... (N=9)	Mean .. SD	99·0 5·4	38·0 12·2
Group 1 Comprehension learners .. (N=7)	Mean .. SD	101·1 7·1	56·0 8·8
		Ineffective teachback on Gandlemuller programme	Effective teachback Operon programme
Group 1 Operation learners .... (N=9)	Mean .. SD	51·0 12·1	109·0 5·2
Group 1 Comprehension learners .... (N=7)	Mean .. SD	57·0 9·8	104·0 6·4
		Effective teachback on Operon programme	Ineffective teachback on probabilistic inference
Group 1 Operation learners .... (N=9)	Mean .. SD	84·1 26·4	47·9 19·9
Group 2 Comprehension learners .... (N=7)	Mean .. SD	98·7 23·9	71·0 16·1
		Ineffective teachback on Operon programme	Effective teachback on probabilistic inference
Group 2 Operation learners .... (N=8)	Mean .. SD	40·1 13·9	103·5 13·8
Group 2 Comprehension learners .... (N=6)	Mean .. SD	62·0 13·1	116·0 30·8

Note: Post-test teachback score is represented as a percentage of the pre-test score.
Statistical summary:

Each student's effective teachback results > ineffective teachback results. Differences are significant for all students (and for all operation and comprehension learners treated as separate sub groups) ($P<0{\cdot}001$, Wilcoxon Matched pairs signed ranks test).

The results from this experimental series clearly confirm those of the earlier study. Matched instruction favours learning and mismatched instruction completely disrupts it (specifically, for explanation eliciting questions) and leads to specific types of misconception. The demand for understanding guarantees retention, whereas the correct response criterion does not usually do so. (A finding similar to that reported by Marton and Säljö, 1976, in terms of deep and surface level processing). Differential learning strategies are adopted and if students are assigned to holist/serialist classes on the basis of their comprehension/operation learning competence, then the learning strategies polarise and transfer over quite widely spaced (two-week) sessions involving different subject matter.

In these experiments all students were also given standard tests for various cognitive traits (logical reasoning, embedded figures, analogy completion, perceptual discrimination and a test for divergence). The only differences in mean score between groups (holists score higher than serialists, $P<0{\cdot}05$) are on the analogies test and the divergence test.

SECOND SERIES OF EXPERIMENTS

Methods and Sample

The various methods being used in the second series of experiments are as follows:

(a) Intensive tape-recorded individual interviews and small group discussions with teachers.

(b) Material reported in this paper is based upon over 80 interviews with students, of which 46 were mainly concerned with reaction to INTUITION (as in the previous paper).

(c) The INTUITION system programmed for a thesis on probability theory and decision. The laboratory-like modelling-facility is STATLAB (previous paper). This technique provides exceptionally detailed automatic records of all the learning transactions.

(d) ' Free Learning ' and ' TEACHBACK ' using a modelling facility for heat engines and an appropriate conversational domain.

(e) Approximations to INTUITION and TEACHBACK, based on conversational domains for different subject matters, but allowing for group and classroom operation.

(f) Techniques for studying innovation, ' teaching people to learn ' and inducing ' learning to learn '.

(g) A specific test, the ' Spy Ring History ' test was developed during the first series of experiments to provide a convenient method of estimating an individual's bias towards operation learning, comprehension learning, or versatility. The test is described in Tech. Rep., 1974, and the Appendix. Administration occupies between one and two hours and students are required to learn and recall the growth of an ' International Spy Ring ' over five historical epochs. Recall questions are loaded to favour operation learning, comprehension learning or neither. Percentage scores are calculated as comprehension bias/operation bias, versatility, and overall success. The test has been administered to 65 students (5th and 6th form) at Henley Grammar School, 40 from the Architectural Association school of Architecture and over 50 from other schools and colleges. Of these, 23 students subsequently used the INTUITION system so that an unambiguous learning strategy record is available for scrutiny and there is a significant ($P<0{\cdot}001$) positive correlation between the comprehension score and indices of holism, with the operation score also being related to indices of serialism.

RESULTS

Comprehension learning, operation learning and their defects

Comprehension learners, operation learners and versatile students who use both modes of learning (as judged by results from the Spy Ring History test) appear to tally with mental propensities noted in the course of interviews with both teachers and pupils. Certain pathologies of learning are also consistently acknowledged by a large number of tutors and schoolteachers, and many of these are predictable consequences of unsuccessful comprehension learning and unsuccessful operation learning. Two outstanding pathologies have been christened *globetrotting* and *improvidence.*

Globetrotting and improvidence are most easily exhibited in the context of analogy relations such as the correspondence between an electrical oscillator and a mechanical oscillator, an example used in the previous paper. This, like any other analogy representable in a conversational domain, is a *valid analogy*, i.e., there is a systemic/formal principle (simple harmonic oscillation) in common to the analogous topics and there are differences of semantic interpretation (for example, the distinction between an electrical and a mechanical oscillator). Moreover, the analogy relation only ' works' if the proper correspondences are recognised between the subordinate topics (mass/inductance; elasticity/inverse capacitance and friction/resistance). Other subordinate correspondences which might be imagined would lead to inconsistency and a misunderstanding of the valid analogy. There are also *vacuous analogies* where two or more topics are described and believed to have a systemic/formal principle in common, but do not actually have one. The following example exhibits the use (not the understanding) of a vacuous analogy. A students says " A termite's nest is like an ant hill and an ant hill is like a city ". Asked what a city (termite's nest) is like he says " an ant hill ". Asked what an ant hill, or termite's nest is like, he may or may not be able to give an explanation; for example, " a social organisation of insects employing signalling devices, mostly chemotactic, and constrained by architectural pathways . . .". If not, his construction is tautologous. If so, he has still appreciated a vacuous analogy if the same explanation does not characterise the other two topics, i.e., if asked " how does that organisation apply to a city " he is unable to reply, or if his reply is factually mistaken. Finally, there are students who fail to make use of valid analogies that do exist; for example, it is not uncommon for students to learn the concept of an electrical oscillator and (even though they are told and genuinely appreciate that the same formal equations govern mechanical oscillators) to learn about mechanical oscillators from scratch. Nearly all the effort could have been saved, if the common principle had been used (rather than merely verbalised as a formula). The phenomenon is ubiquitous, especially in cross-disciplinary studies. It is deprecated, but not avoided.

Globetrotting may now be defined as the misunderstanding of valid analogies the use of vacuous analogies or both, while *improvidence* is failure to use valid analogies, failure to use a common principle, or both. The Spy Ring History test has a well specified entailment structure which is rich in correspondences that, if interpreted, become analogy relations; for example, between spy roles, between countries, and between the networks of different epochs. Hence it is possible to count the ' globetrotting ' and ' improvidence ' errors of respondents and to correlate their frequency with the test scores. There is a positive rank-order correlation ($r=0{\cdot}30$, $P<0{\cdot}05$) between the comprehension score and globetrotting errors and a positive rank correlation ($r=0{\cdot}26$, $P<0{\cdot}05$) between the operation scores and improvidence errors. If versatile students are removed from the sample (to yield a residue of successful/unsuccessful comprehension/operation learners) these error correlations are increased. They are still further increased by limiting attention to the less successful students who committed more errors of any kind. For example, amongst students scoring less than 70 per cent, the correlation between comprehension score and globetrotting error is 0·57 ($P<0·01$) and that between operation score and globetrotting errors is 0·55 ($P<0·01$). Preliminary work on the analysis of essays written by students who have performed the test, indicates that even higher correlations exist between the comprehension and operation scores and the frequency of errors due to globetrotting or improvidence.

Studies of learning probability theory using the INTUITION system

The general findings of the previous laboratory studies have been confirmed. The detailed records of learning (18 to 26 hours learning time per student, excluding test time and interviews) always show polarisation. Further, if the choice of learning strategy is guided by advice based on knowledge of learning styles, then the learning is effective and understanding leads to retention.

Altogether, 56 students have used INTUITION. Due to the difficulties of operating a system within institutional timetabling constraints (for example, ' break points ' must occur at change of an aim topic; if this self-paced event does not fit into the timetabled period, much, or all, of the record must be discarded) summary performance data is presented in Table 5 (I) only for 11 carefully studied A-level students at one grammar school where the restrictions are less severe. (The remaining results are available on request.) Detailed records of learning cannot be concisely displayed but are made in each case. For example, Figure 1 shows fragments (less than a tenth) from the record of a holist (caption for serialist) in the group of 11 students. Apart from the information shown in Figure 1, the system records the progress of aim validation (as confidence estimates) explored topics, and the steps taken to remedy mistaken explanations.

Studies of the mechanisms underlying defective learning

As characterised by the Spy Ring History test, comprehension learners are prone, if left to their own devices, to act as holists. Operation learners are more likely to act as serialists. The versatile students have initially a greater degree of freedom, but their behaviour becomes polarised after they have tackled about a dozen topics. All students who manage to learn, do, by one means or another, reach the understanding demanded by the standard condition. This is a consequence of two facts. The operating ritual is devised so that they *must* do so, and the conversational system provides the information needed in order that they *may* do so.

Our hypotheses about defects in learning stem from these *facts* and the premise that *understanding* a topic, in the strict sense of the previous paper, involves *both* comprehension learning, which was identified earlier with description building, *and* operation learning, which was identified with procedure building. This premise depends upon the idea, which appears self-evidently true, that any organisation, human, animal or mechanical, which builds programs or procedures on the basis of other programs or procedures, can operate efficiently only if it is first given, or constructs, a description of what the procedure to be built must do and the circumstances under which it will be executed. The alternative process of trial and error combinations of existing procedures, which depends on the elimination of the many combinations which do not work, is so grossly inferior as to be impracticable, except for a very restricted type of task.

TABLE 5

PERFORMANCE OF STUDENTS UNDER LEARNING CONDITIONS WITH VARYING DEGREES OF CONTROL.

<table>
<tr><th rowspan="2">Learning Condition</th><th rowspan="2"></th><th rowspan="2">Written Post test score</th><th rowspan="2" colspan="2">Mean time per topic in mins.</th><th rowspan="2" colspan="2">Mean frequency of Mistaken Explana-tions</th><th colspan="3">Spy Ring History Test Scores</th><th rowspan="2">Subjective estimate of Globetrotting (II) or Improvidence (III) as percentage of topics addressed</th></tr>
<tr><th>Success</th><th>Operation (+) Compre-hension (−)</th><th>Versatility Index</th></tr>
<tr><td rowspan="3">(I) Entailment Structure Explanation Demanded (N=11)</td><td>Mean ..
SD ....</td><td>96·5
4·0</td><td colspan="2">9·3
2·1</td><td colspan="2">0·16
0·04</td><td>0·56
0·12</td><td>0·1
0·35</td><td>0·19
0·21</td><td>—
—</td></tr>
<tr><td></td><td></td><td>Mod-ule 1</td><td>Mod-ule 2</td><td>Mod-ule 1</td><td>Mod-ule 2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mean ..
SD ....</td><td>—
—</td><td>9·7
2·9</td><td>6·6
1·4</td><td>0·12
0·05</td><td>0·02
0·02</td><td>—
—</td><td>—
—</td><td>—
—</td><td>—
—</td></tr>
<tr><td>(II) Entailment structure Multiple choice correct response (N=10)</td><td>Mean ..
SD ....</td><td>67·7
21·0</td><td colspan="2">12·2
2·6</td><td colspan="2">Not
recorded</td><td>0·52
0·07</td><td>0·48
0·18</td><td>0·12
0·07</td><td>8·1
1·6</td></tr>
<tr><td>(III) Denuded entailment structure Multiple-choice correct response (N=10)</td><td>Mean ..
SD ....</td><td>67·0
17·0</td><td colspan="2">12·8
2·8</td><td colspan="2">Not
recorded</td><td>0·6
0·07</td><td>−0·16
0·22</td><td>0·19
0·06</td><td>12
2·15</td></tr>
</table>

Statistical Summary:

Test Score (I) > Test Scores (II) or (III). P<0·001 (Mann Whitney U test).

Time/topic (I) < Time/topic (II) or (III). P<0·05 (Mann Whitney U test).

For (I) on transfer data: Time for Module 1 > time for Module 2 (P<0·01, sign test). Mistakes for Module 1 > Mistakes for Module 2 (P< ·01, sign test).

For (II) significant positive rank correlation between individual comprehension/operation learning index and individual globetrotting (P<0·001)

For (III) significant negative rank correlation between individual comprehension/operation learning index and individual improvidence (P<0·05)

In the previous paper a *concept* for a topic was defined as a procedure for realising that topic. Thus *understanding* a topic (the construction of a stable and memorable concept) nearly always involves a phase of description building and a phase in which a procedure (i.e., a concept) is built to realise the description. This type of, perhaps, ' deep-level ' processing appears to be the dominant mode of human learning, although in animals the trial and error combination may be more significant. If this view is accepted, then understanding a topic involves both description building (comprehension) and procedure building (operation learning) as suggested.

As we have seen the standard condition of a conversational system demands that topics are *understood.* Further, the system provides differential support. The entailment structure and its description, perceived through the 'explore' transactions, aid the student in building a topic description, while the demonstrations derived from the *behaviour graphs* attached to each topic, furnish prescriptions for procedure building. When the understanding condition is satisfied it follows (both theoretically and empirically) that neither of the two pathologies described earlier can be present. The explanation component of *understanding* prevents ' globetrotting ' while the derivation component inhibits ' improvidence ' and prevents total improvidence.

In order to investigate these pathologies the constraints upon the conversational system must be relaxed. One approach is to replace the requirement for explanation of a topic, by requiring only correct responses to some six or eight multiple choice questions that span the topic. This criterion can then be achieved by a less thorough understanding; even by 'surface processing' in Marton and Säljö's sense. A second approach involves reducing the support provided by the conversational system. When this is done various defective kinds of learning become possible, and can be investigated. These pathologies would also be found under classroom self-study conditions where again the ' understanding ' requirements are not stringent and there is little control of the learning process.

Two conditions of this type have so far been investigated.

(a) Explanation is replaced by a correct response criterion, but the entailment structure remains intact.

The prediction under this condition is that comprehension learners, who are not versatile, will exhibit ' globetrotting '. The summary data in Table 5 (II) supports this hypothesis and the expected tendency is strongly evidenced by the detailed records. For example, examination of the exploration patterns and aim selections reveals a distinction between the global and local types of description noted earlier.

(b) Explanation is replaced by a correct response criterion and the entailment structure is denuded of all analogical relations.

The prediction under this condition is that operation learners who are not versatile will exhibit ' improvidence ', since they are no longer supported by an adequate descriptive scheme. The evidence that this hypothesis is also supported is presented in Table 5 (III).

In contrast, versatile learners are not greatly influenced either by relaxing the constraints or differentially withdrawing support. It appears that they habitually learn by understanding whether forced to do so or not.

Transfer and Learning to Learn

An appreciable transfer of learning takes place due to experience in CASTE, INTUITION, or Teachback over a conversational domain. The gross results shown in Table 1 and Table 5 conceal an important underlying transfer of general aptitude, due to the fact that a student learns a great deal about his own mental processes. This aptitude appears to transfer from one subject matter to another (for example, ' probability theory ' to ' heat engines ') and scrutiny of detailed records such as those illustrated in Figure 1 suggests that it constitutes an increase in versatility. Recent data obtained by pre- and post-testing with different forms of the Spy Ring History test, are not at odds with this proposition.

Can ' gaining versatility ' be equated with ' learning to learn '? and as a practical consequence, can ' conversational experience ' thus be regarded as ' training the skill of learning '? If the environment of knowledge and events was structured like a conversational domain, or even like the scholastic environment of libraries and educational media, the reply would be affirmative. But the usual connotation of ' learning to learn ' also comprehends an ability to structure and make sense of otherwise unordered experience. For this, more than versatility is required. What is required is the skill of building up an approximation to a personalised conversational domain. Understood in this way ' learning to learn ' could have great practical value in education.

A Classroom Implementation of ' Learning ot Learn ' Principles

Pilot studies have so far been limited to intensive study of 24 students from the sixth forms of two schools and from a college of education. Four separate groups have been used. The experiment occupies five sessions, each of approximately two hours duration. In the first session the students in a group are confronted with the following situation. They are to imagine that they have entered a course entitled *Cosmic Processes* (any other non-commital but interesting title would do, just as well) but have failed to attend the lectures. Today they are due to take a chiefly explanation/essay type of examination and have a couple of hours in which to scan through relevant test materials (X). With this ' story ' the students are given meaningful extracts from diverse authors (Bateson, Castaneda, Jung, Kelly, Lilly, Schrodinger, Wittgenstein). There is far too much to learn but the underlying topics can be related in many coherent ways. Towards the end of the first session each student is provided with a sheet displaying the names of 35 salient topics, arranged as a ring; further topic names may be, but rarely are, added. (All additions made as a result of pilot studies are entered on this list.) Each student marks with a ' plus ' sign those topics he feels certain he could explain and with a ' minus ' those topics he certainly could not explain. He is asked to connect topics, which he believes to be related, by ' links ' to form an associative network. After that, students undertake an examination.

The second session starts off with the delivery of computer processed graphics, derived from the ' network ' from the first session. Training in general learning habits is given and is based upon the personal graphics and upon different, though similarly diverse, texts. The training, which extends into the third session if necessary, is a non-technical presentation of principles derived from CASTE (for example, reaching the understanding of a topic) discovery of defects such as ' globetrotting ' and their remedy, and principles of subject matter structuring (building a conversational domain) which stem from the operation of ' course assembly systems ' (Pask, 1976). Although these principles are quite definite and can be stated rigorously, they are presented in a non-technical manner, using exercises and a study guide which students are free to take away.

The fourth session is a repetition of Session 1 using an again different set of text materials (Y). Both X and Y were chosen as bundles of material dealing with very different topics, each bundle being superficially unordered but each open to structuring in many self-coherent ways. The reading time and scoring time for materials X and Y (used in sessions 1 and 4) are matched. (The position of X and Y has been changed around with different pilot groups and the content of X and Y, though different, appears to present about the same degree of difficulty.) At the end of the fourth session relevant topics are marked with plus and minus signs and a further associative network is drawn by each student. After that the students submit to an examination covering all topics on the sheet describing the network elicited.

At the beginning of the fifth session students receive a computer processed form of their associative net; being a graph representing how they individually relate topics in Y. Discussion is encouraged. Finally, all students perform the Spy Ring History test as a stylistic discriminator.

During pilot studies (using a dozen paid respondents) a baseline control condition was established. The second and third sessions were devoted to learning and examination of the materials currently used for training but with no specific training or study guide provided. Under these circumstances, learning performance does not improve and usually flags off, due either to cumulative overload or an initial Hawthorne effect.

For the experimental condition it is possible to compare topic relating graphs for the two topics X and Y, the ' plus ' topics for X and for Y, the number of ' plus ' topics that are actually explained in the examination, and the examination scores for X and for Y. The tendency of the control condition is usually reversed (Mean examination score (Y)$>$mean examination score(X) is significant $P<\cdot 01$). So far, all students have been conservative in marking ' plus ' topics (i.e., they are able to explain ' plus ' marked topics), but the number of ' plus ' marked topics increases with training ($P<\cdot 05$). Graph connectivity, determined by several graph decomposition indices (Ashby, 1964; Atkin, 1973), significantly increases ($P<\cdot 001$) with training, whereas in the control condition there is a significant decrease. These objective indices support the consensual opinion gained from discussions that trained students gain a general insight into structuring and learning an unordered and previously unknown collection of topics. There are, however, exceptions to this general trend. First, there are students with a uniformly high examination score for X and Y materials (8 out of 24 in the sample studied.) These students, who are apparently able to learn from the outset, always have high (45 per cent or greater) versatility scores and there is an increase in the connectivity of their topic relation graphs. Next ,there are students (3 out of 24) who fail completely, their examination score for Y material being less than the score for X material. In the sample studied these students have a bias to operation learning, a low versatility, the graph connectivity for Y topics is less than that for X topics (in fact their Y graphs are fragmented into small sub-graphs), and their confidence in being able to explain topics also decreases.

The important conclusion to be drawn from this final experiment to date in this on-going research programme is that it is possible, with a few exceptions, to teach students to learn more effectively by the application of sophisticated principles of learning. The principles can, however, be presented in a simple, non-technical manner suitable for use in a classroom.

Current research is looking at the problem of generalising from X materials to Y materials and vice versa, and also at transferring academic subject matters into a self-study form. In general the research reported in this series of experiments has developed the ideas on conversational techniques of learning to the point where important practical implications for education are beginning to emerge.

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APPENDIX

THE ' SPY RING HISTORY ' TEST

The ' Spy Ring History ' test for Comprehension/Operation learning has antecedents in the work of Hayes (1965) and Michon (1966) upon learning lists of ordered pairs. Names in the lists denote spies, and pairing their connections (Boris, Abel), for example, means that Boris can communicate with Abel. Taken as a whole the list specifies a spy network (i.e., a directed graph, with spies at the nodes and arcs indicating who can communicate with whom). Respondents may or may not be able to build up a visual image of the graph if the name pairs are presented and learned in sequence, though, if the network is shown graphically, it is easily grasped.

The ' Spy Ring History ' test is founded upon a cartoon or graph product (Winner, 1973), each graph representing successive spy networks in the years 1880, 1885, 1890, 1895, 1900, during which organisational changes take place, some of them quite regular. (For example, the network falls apart, or there are 'bottleneck' situations.) Moreover, the spy names (or spy roles) do not change over the interval, and may be consistently assigned, by further predicates, to different imaginary countries (Ruritania, Dionysia and Olympia).

Students are told, at the outset, that they are learning the development of a spy network interlacing the countries over the epochs specified. However, they receive information only in the form of paired associate lists of spy names, with the caveat that each list is to be faultlessly memorised. In later versions of the test, the lists of paired names are slightly redundant. They purport to represent a sequence of observed messages which are presented with the caveat that any list of what messages *were* sent at a given epoch covers all the messages that *could have been sent* (that is, the connections permitted by the network of the epoch in question). Hence, in a formal sense, all students have the information needed to answer any question correctly. They also appreciate that questions of various kinds will be posed later on.

After learning, students are questioned (see Tech. Rep., 1974) to elicit complete information about the entire history. Students are seldom able to provide all the information required; but they give what they can in one of at least two patterns. It also seems they learn in at least two different ways.

Some students, classified as *comprehension learners* (potential holists), can answer synoptic questions like " What went wrong with the spy system around 1885? " or even predictive questions such as " Do you think that outstanding events are likely to be repeated in 1905; if so, why?." Other students, classified as *operation learners* (potential serialists) focus upon the individual networks or even the paired associate lists; for example, " How could Abel communicate with Boris in 1890; by how many paths; what are they? " or even " Draw the spy network for 1890." The scoring scheme taps each kind of knowledge differentially, so as to discriminate between comprehension and operation styles of learning; it also includes a score for neutral questions favouring neither style. All students are required to answer each kind of question as well as intermediary enquiries like " Draw the boundaries of Dionysia, Olympia, and Ruritania on a map " and " Say which of the agents belong to each country."

Provided the overall and the neutral scores are high enough (which depends upon personalised group administration, or, at any rate, feedback to ensure that the lists are learned) it is possible to distinguish stylistic tendencies as follows:

(*a*) Operation learners who are also successful in deriving general properties.

(*b*) Operation learners who can recall details but cannot answer general questions.

(*c*) Comprehension learners who also successfully derive details.

(*d*) Comprehension learners who recall the overall scheme but cannot answer particular questions.

(*e*) Versatile students who correctly answer questions of each kind and apparently use several derivation methods.

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THE INFLUENCE OF QUESTIONS ENCOUNTERED EARLIER ON LEARNING FROM PROSE

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Summary. 24 undergraduate students each studied three similar meaningful prose passages on quasi-geographical material, and their learning was measured by subsequent recall tests. Subjects who received test questions asking about parallel and similar contents of each passage performed considerably better on the third passage than subjects who were then given a test including questions about ideas in the prose text that did not parallel those tested following study of the earlier passages. This finding indicates one powerful influence upon students' learning.

INTRODUCTION

It has long been abundantly clear that the manner in which we perceive information that reaches us is influenced by a variety of our individual attributes. Personality, attitudes, prejudices and opinions undoubtedly influence our perception and our understanding of events. So far as visual information is concerned, the latter statement is supported by a large number of phenomena encountered in experiments on non-veridical perception (see, for example, F. H. Allport, 1955) and the role of individual factors in influencing understanding was perhaps most clearly documented in the work of (G. W.) Allport and Postman (1947) upon the perception of rumours.

Such personal and individual factors must also influence the acquisition of knowledge, through learning. However, whereas the effects of ' set,' attitudes, and other subjective influences upon perception have been amply documented there has been relatively little systematic research aimed at investigating the role of such influences upon learning. Experiments studying the effects of set and expectancy in human learning have most often manipulated factors that are peripheral to the actual material being learned, and which do not closely involve the detailed contents. For example, a large number of experiments examining study behaviours known as ' mathamagenics ' have varied parameters such as the spacing of questions, the positioning (e.g., before or after students read the material upon which the questions are based) and the length and number of prose passages (e.g., Rothkpof, 1970). It might be argued that least marginal significance ought to be attached to the effects of expectancies set up by the precise nature of the material, since studies of perception have drawn attention to the significance of the relationship between the material the individual encounters and his own attitudes over expectancies. There is clear evidence that the form of prior questions can influence learning. Rothkpof and Bisbicos (1967) interspersed in a prose text questions which related to either common or technical terms, and they found that the students who had encountered questions about technical terms subsequently showed high recall of other technical items. Watts and Anderson (1971) discovered that subjects who received questions that required them to apply the principles they had read in a prose passage to new situations performed better in a recall test than subjects who answered questions that simply repeated examples in the text. The authors suggest that answering questions which require the application of principles may improve performance by encouraging students to process the contents more thoroughly. However, it is equally possible that the advantage of the application questions used in their experiment was due simply to the increased effort required in having to answer more difficult questions.

The present experiment was designed to discover whether or not the presentation to students of successive prose passages that are similar in content and are followed by highly similar sets of questions related to them, has the effect of inducing a ' set ' or expectancy, whereby subjects studying subsequent similar passages concentrate their attention on those aspects of the new passage which correspond to the parts of the preceding passages about which questions have been asked. The object of the experiment was to investigate such effects, insofar as they affect performance on measures of learning. How, if at all, do expectations influence learning either of the information in a passage on which a subject expects to be tested, or of other items, or both? The possibility that the present experimental design would show evidence that students' learning may be influenced by their expectations in relation to the actual content on which they would be tested was raised by the results of a previous experiment (Howe and Colley, 1976) designed to investigate retroactive interference in meaningful prose learning. An unexpected side result of that study was that some subjects who had been exposed to a short series of prose passages followed by subsequent recall tests did appear to have developed some kind of set to pick out and remember the particular details of a new passage that were similar or related to those parts of earlier materials that were involved in the tests. It thus appeared appropriate to design an experiment that would investigate in a more systematic manner the possibility that learner expectations of this kind can affect learning of the kinds of meaningful prose materials that students are likely to encounter.

METHOD

Sample.

Twenty-four undergraduate university students participated. They were drawn from a voluntary ' subject-pool.'

Materials.

The prose materials were constructed as follows : A ' standard ' passage was composed, 20 sentences in length, totalling approximately 350 words. The passage contained geographical and historical information about a fictitious country. Each sentence was constructed so that it could be divided into two major ' idea units.' For example, " The North of Perovia contains its most rugged scenery,/where the land consists mainly of sandstone " or, " State education has been provided for 60 years,/and is compulsory after the age of 5." Two further passages about fictitious countries were then constructed from the existing passage, by changing the name of the country throughout, and altering two specific ' facts ' in each sentence, one in each of the two idea units. Thus the two sentences above were modified to yield, " The East of Saraland contains its most rugged scenery,/ where the land consists mainly of granite " and, " State education has been provided for eighty years,/and is compulsory after the age of six."

Two sets of recall tests (type A and type B) were constructed. Each test contained 20 short-answer questions on one of the passages. Every question related to a specific detail in one of the idea units in a sentence, and the questions were arranged in the same order as the sentences in the passage. There were three type A tests, which consisted of the same set of questions for each passage, the name of the country being changed appropriately. The three type B tests (again one for each country) each consisted of 20 questions related to the other 20 specific details that differed between each of the three passages, that is the remaining main idea unit in each sentence. Thus, for every passage there were two alternative recall tests, which between them covered all 40 of the main idea units of the prose passage.

Procedure.

Subjects were tested in small groups containing two to four individuals. They were told that the experiment formed part of a study examining the ways in which different methods of presenting information in written form affect the ease of learning. Each subject was given all three passages to study, one at a time, in a predetermined order, and asked to try and remember as much of the information as he could. Three minutes were allowed for studying each of the passages, and subjects were informed when only one minute remained. Subsequently, subjects were required to copy a table of random numbers, and after 50 seconds of this activity they were told to stop. The purpose of this task was to minimise further rehearsal of the material recently studied. Next, the appropriate test was handed out, and the subjects were told that they would be allowed two and a half minutes to complete the 20 short-answer test items. The test period was followed by a 30-second pause, following which the procedure was repeated for the second passage, and subsequently for the third.

The type of test that was chosen to follow each passage for a particular subject was determined as follows : Each individual was assigned to one of two experimental groups. Subjects in Group One received the same form of test after each passage, either type A, for half of these subjects, or type B. Subjects in Group Two were given the same form of test for each of the first two passages they studied, but the alternative kind of test following the third passage. (Half of these Group Two subjects received two type A tests, followed by a type B test, and the others were given two type B tests for their first two passages, followed by a type A test of their third passage.) Within each of the two conditions, the order of presentation of the three passages was systematically varied, in order to control for any intrinsic differences in the difficulty of learning the information in the separate passages. (Such differences were likely to be negligible, since the passages are identical in conceptual structure, differing only in specific facts.)

After the completion of the third test, each subject was asked about his manner of learning the passages and about any expectations he held concerning the questions to follow the third passage. Open-ended enquiries were made at first to avoid ' suggesting ' strategies, and individuals who did not provide a clear statement concerning their expectations were asked more direct questions, in order to ascertain whether or not they had anticipated being asked the same questions on the third passage as on the first two, and, if so, whether they had concentrated on those aspects of the passage they anticipated being chosen for the test questions.

RESULTS

Subjects' test responses were classified as follows :

A. Correct.

B. Incorrect, and a possible 'intrusion' from another passage (i.e., a response which would have provided the correct answer for the corresponding question on a passage which the student had studied previously).

C. Completely incorrect.

D. Omissions.

Occasionally half marks were given, for instance, if a name was supplied in which one or two letters were incorrect. A note was also made of the number of type C answers which would have been classified as intrusions if the subject had previously read the relevant passage. For purposes of statistical analysis these ' pseudo-intrusions ' were counted as being in category C (completely incorrect responses).

TABLE 1

SUMMARY OF MEAN TEST SCORES.

	1st Passage			2nd Passage				3rd Passage			
	(a) correct responses	(c) incorrect	(d) omissions	(a) correct responses	(b) intrusions	(c) incorrect	(d) omissions	(a) correct responses	(b) intrusions	(c) incorrect	(d) omissions
Group One	14·21	2·58	3·21	15·08	0·33	2·92	2·92	15·58	1·00	1·17	2·25
Group Two	13·04	2·58	4·38	14·13	0·42	2·88	2·58	10·17	2·13	1·50	6·21

Table 1 shows the mean scores in summary form. The scores for the number of correct responses provided by subjects on each of the tests were submitted to an analysis of variance. The main effect of the experimental condition (i.e., three tests of similar form *versus* two similar ones followed by a different test) was significant, $F(1,20)=5\cdot37$, $P<\cdot05$. The main effect of the passage positions was also significant, $F(2,40)=4\cdot45$, $P<\cdot025$. The interaction of these two accounted for most of the variance, $F(2,40)=9\cdot65$, $P<\cdot001$. This highly significant interaction between the experimental condition and the passage position, as determinants of the number of correct test responses, is largely due to the drop in the scores of Group Two on the third recall test, i.e., the test which markedly differed in form from the previous two. This drop from a mean score of 14·13 correct responses (out of twenty) to 10·17, as shown on Table 1, is highly significant ($P<\cdot001$) and contrasts strikingly with the near equivalence (15·08 against 15·58) in test scores between the second and third passages for subjects in Group One who received tests that did not alter in form. There was no significant effect due to form of test, $F(1,20)=0\cdot12$, indicating that there was no intrinsic difference in the difficulty of the two types of test. No other interaction was statistically significant.

In short, subjects who received questions on their passage which were different in form from those encountered after the first two gave a substantially lower number of correct answers on the third tests than did subjects who were given three similar tests. It was not clear at this stage whether this significant difference ($P<\cdot001$) was related to conscious expectations on the part of participants, and to investigate this matter a further analysis was undertaken, based on subjects' replies to the experimenters' subsequent queries about expectations and learning strategies. Within each experimental group, a comparison was made between the scores of those subjects who reported that they expected, or considered it highly probable, that questions on the third passage would be similar to those asked on the previous passages (approximately half the subjects in each group) and the scores of those individuals who reported no such expectation. In neither of the experimental groups was there a statistically significant difference in the appropriate scores obtained by students in these different categories. In other words, students' reports of their expectancies were not significantly related to their actual success in the tests for recall of the information.

Comparisons were made between the numbers of omissions, complete errors and intrusion errors made by the subjects in the two experimental groups. There was no significant difference in number of omissions on either of the first two tests, but there was a large (2·25 against 6·21) difference on the third test ($U = 20$, $P < \cdot 001$). Not all the difference between the totals of of correct responses by the two groups can be explained by an increase in omissions: while there was no significant difference between groups in the numbers of complete errors on any of the three tests, there was a significant difference in the number of intrusion errors occurring on the third test ($U=32$, $P< \cdot 025$).

A possible explanation for the significantly greater number of intrusion errors made by Group Two on the third passage is suggested by the fact that for any given question following that passage more than one possible answer (i.e., appropriate response to a corresponding question encountered in the course of the session) was available. Subjects in Group One who could recall an item appropriate to a preceding passage would be likely to have already given that item as a previous test response. Subjects in Group Two, however, would not have used the item as a recall test response, and hence might have difficulty in discriminating between such earlier items and the particular information in the third passage required for a correct response.

DISCUSSION

The experimental findings strongly confirm the prediction that prose learning would be influenced by the 'set' induced by the nature of the questions following previous prose passages. Performance at recall tests was appreciably better when the questions were similar to those asked in connection with the earlier passages than when they were different. The possibility that the difference in scores might be due to the differing 'familiarity' of the two forms of test appears to be ruled out, since levels of performance on the first test encountered are uniformly high (see Table 1).

However, the data from subjects' reports indicate the possibility that the difference in performance between subjects in the two experimental conditions was not due to any conscious expectancies about the nature of the questions to be asked in the recall tests. Surprisingly, less than half of the subjects gave any evidence of attending to or remembering the form of the questions, and those subjects whose reports did suggest the possibility of their having formed some expectations about the test questions did not perform differently in any detectable manner from other subjects in their respective experimental groups. These findings indicate that an explanation of the present findings which is solely based on conscious expectancies may be less than adequate. One possibility is that the points of information that in previous passages had been followed by questions came to 'stand out' to students as they read the third passage. Yet the evidence suggests that insofar as there may have been deliberate concentration upon certain points, this was not related in any apparent manner to levels of performance. The question of whether subjects have to be aware of any changes in their 'set' for performance to be affected thereby raises a matter of some importance which merits further investigation. However, the present experimental design, which was not intended to provide solid evidence concerning subjects' awareness does not permit any firm conclusion on this issue.

Whatever the correct explanation, the finding that the contents of previous questions can influence performance in a learning task is an important one, since it provides clear evidence of one rather subtle, and insufficiently recognised way in which the individual's learning may be influenced by past experience. The kinds of human learning that contribute to the process of education are numerous and varied. Their documentation through research investigations such as the present study contributes to our knowledge of the complex pattern of influences that determine what a student will actually learn from the instruction he receives and from the facilities for learning he is offered.

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SOUND BLENDING AND LEARNING TO READ : AN EXPERIMENTAL INVESTIGATION

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SUMMARY. 60 4- to 6-year-old children were involved in two experiments, carried out to determine whether training in sound blending facilitates subsequent learning to read. Results showed (i) that children of these ages improved their performance on a sound blending post-test, (ii) that 5- 6-year-olds performed better on a subsequent reading task than children not given sound blending training, and (iii) that 4- 5-year-old girls trained in sound blending performed better on the reading task than similarly trained boys of the same age. Rather than an overall superiority of girls on sound blending and reading, there appeared to be a specific difference between the sexes in response to training.

INTRODUCTION

RESEARCH effort can profitably be directed towards identifying the specific processes and skills that are needed for a child to learn to read, since only when these are identified can we expect success in devising and evaluating pedagogical methods. We maintain that three steps are necessary: (i) to establish experimentally the processes and skills which are necessary and sufficient for children to learn to read; (ii) to devise methods of instruction based upon these skills; (iii) to evaluate these methods, both experimentally and in field trials. We maintain also that while the study of children with reading difficulties is a thoroughly laudable endeavour and should continue, its findings are as likely as not to be irrelevant to identifying the skills and processes which are necessary and sufficient for *initial* learning to read. When we know which skills and processes are necessary and sufficient, those which are absent or deviant in a child having difficulty may more readily be identified.

We take the position that language is a system of spoken sounds which may be represented by a system of graphic symbols. We accept, with Carroll (1953), that spoken language is the primary form while written language is secondary, and that this order is a proper one to observe when considering the factors involved in learning to read. Children have established some degree of control over spoken language before they are required to learn the system of written language; this first set of skills can be used to help them master the second.

There is evidence that before children reach six years of age they have some facility with many of the phonological, syntactic, and semantic structures and organisations of spoken language (Basser, 1962; Berko, 1958; Chase, 1967; Menyuk, 1969; Roberts, 1958). However, while young children have basic structures of spoken language at their disposal, other evidence (Carol Chomsky, 1969) indicates that children continue to acquire more complex syntactic structures up to the age of nine years and perhaps beyond. Thus, the extent to which written language is dependent upon spoken language may impose a ceiling on what can be acquired of functional written language in the early years.

However, spoken language and written language differ quite dramatically, at least in surface structure, a fact exemplified by comparing a tape recorded conversation and a written set speech. The shifting sound values of letters constitute another set of differences between written language and the symbols which represent it. Carol Chomsky (1970) made a useful distinction between mature and beginning readers. She argued that beginning readers may assume that orthography is phonetically valid, with each symbol representing a constant single sound, while mature readers have abandoned this assumption, interpreting written symbol combinations as abstract lexical spellings. Beginning readers must free themselves from this assumption before they can progress to more advanced reading skills. Unless they do, they will be unable to read accurately when faced with, say, a single letter representing several different sounds, or several different letters representing a single sound.

No single definition of reading has been agreed upon (Otto, 1972), but for the purposes of this study of beginners' reading Strickland's (1964) definition was accepted: reading is a recoding process, acquired when a child has learned to " . . . recognise symbol-sound correspondence to the point that he can respond to the marks with appropriate speech" (p. 10). This definition is limited deliberately to implying that a reader is basically a mediator between graphic symbols and sound symbols; reference to understanding, communication, or to possible neurological or other central processes, is excluded. Important though these issues are, they appear only to confound the question of identifying those processes and skills necessary and sufficient for a child to learn the *beginnings* of reading. We are satisfied that this initial mechanistic assumption is justified in research whose aim is to specify the nature of the programme needed when a human child-computer is learning to change one code (graphic) into another (sound or speech) reliably and validly.

This approach implies a stage model of language with a reciprocal input-output system of processing. Kirk and McCarthy's (1961) adaptation of Osgood's (1954) model of language provides one such framework. Osgood postulated a two-stage model of language, decoding and encoding, with three levels of organisation. Kirk *et al.* (1968), extending earlier work (Kirk and McCarthy, 1961), proposed a model with three functional stages: decoding (receptive), organising (association), and encoding (expressive), at the representational level, and a set of processes at the automatic level sampling closure and sequential memory. We are here concerned mainly with the automatic level which, we argue, comprises a set of mechanical skills necessary if a child is to "recognise symbol-sound correspondence to the point that he can respond to the marks with appropriate speech" (Strickland, 1964, p. 10). These mechanical skills are: grammatical, auditory, and visual closure; sound blending; auditory and visual sequential memory.

Auditory processing appears to be highly involved in language development, though apparently it is not a necessary condition (for example, totally deaf persons can learn to use language, albeit with considerable difficulty). Indeed, there is considerable uncertainty about the nature and extent to which auditory processing is involved with reading (Cruickshank, 1961; Daniels and Diack, 1956; Deutch, 1964; Durrell and Murphy, 1953; Flower, 1963; Goetzinger *et al.* 1960; Hardy, 1962; de Hersch *et al.*, 1966; McCarthy, 1954; Orton, 1937; Schubert and Torgerson, 1968). Nevertheless, we argue that research is needed to establish which auditory processing skills are necessary and sufficient for reading, and in the first instance we examined sound blending.

The two issues to which we gave primary attention are these: (i) whether sound blending can be improved through direct instruction using specific exercises, and (ii) if sound blending instruction is effective, whether reading ability is improved (Chall, *et al.*, 1963). A third issue concerned sex differences. There is some evidence (e.g., Gates, 1961, Rabinovitch and Ingram, 1962; Reynell, 1969) that girls tend to perform better than boys at language-based tasks, learning to read included.

Our interest was in children just beginning to learn to read, and the focus of our investigation was the age range 4·00 to 6·06 years. Given that a child learns the mechanical processes of recoding graphic symbols to sounds without undue delay or difficulty, it is probable that reading progress thereafter depends heavily upon higher level cognitive-linguistic skills. We maintain, however, that this is an empirical issue which still requires investigation.

EXPERIMENT ONE

Material.

The material consisted of CVC trigrams made up from two vowels (/i/ /o/) and four consonants (/p/ /n/ /s/ /t/) chosen to minimise auditory confusion (e.g., from voiced and unvoiced sounds), or visual reversal errors (e.g., /d/ and /b/). Each letter represented a single sound throughout.

Two practice examples were used for reading: /pit/ /tot/. Four 'real' words and four 'nonsense' words were used for the sound blending treatment, and another four of each for the reading programme:

	Sound blending	Reading
'*Real*' *words*	/pip/ /tin/ /pot/ /nip/	/pin/ /sip/ /not/ /top/
'*Nonsense*' *words*	/nis/ /nop/ /ton/ /sot/	/pon/ /nin/ /sop/ /tis/

Five sets of cards were prepared:-

Set 1. Each of the six letters was printed on a card with its associated sound recorded on a strip of tape attached to the lower edge.

Set 2. Each of the vowel-consonant combinations (/ip/ /op/ /is/ /os/ /in/ /on/ /it/ /ot/) was recorded on a strip of tape attached to a blank card.

Set 3. Each of the eight CVC sound blending words was recorded on a strip of tape attached to a blank card.

Set 4. Each of the eight CVC reading words was printed on a card and the word itself was recorded on the attached tape in a position enabling a five second delay between visual and auditory presentation of the word.

Set 5. Each of the eight CVC sound blending words was recorded on a strip of tape attached to a card, and a picture was pasted on each card. The positions of picture and sound enabled a five second delay between visual and auditory presentation.

Cards were presented using a Bell and Howell Language Master. A card was inserted manually into a slot and was moved by a feed roller past the sound head at a constant slow speed. A visual display (letter, word, or picture) was thus present during the time that the card was moving.

Procedure.

There were two treatment groups, and each child was trained and tested individually. Treatment Group 1 received (i) sound blending training, (ii) reading training/testing, (iii) sound blending test. Treatment Group 2 received (i) 'look and label' picture treatment, (ii) reading training/testing, (iii) sound blending test.

The sequence of events for the two treatment groups is shown below:

Treatment Group 1

(1.) Teacher's ranking of each child's reading ability (used as covariate).

(2.) Sound blending (Card Sets 2, 3) (i) single sounds (not more than 4 trials); (ii) VC blends; (iii) CVC blends; or (Treatment Group 2) Look and label (Card set 5)—4 trials.

(3.) Reading, presented by Language Master (Card Sets 1, 4) (i) single letters: sound-sign association; (ii) practice examples (/pit/ /tot/); (iii) 8 words : anticipation learning (6 trials) (no. correctly anticipated used as measure of reading).

(4.) Illinois Test of Psycholinguistic Abilities: sound blending subtest (raw scores and ranks used to measure effect of sound blending treatment).

Sample

10 boys and 10 girls ranging in age from 5·04 to 6·03 years, the mean being 5·09 years, were randomly selected from a single class of children in their first year at school. None had known or uncorrected sensory deficits or was mentally retarded. Bilingual or polylingual children were excluded, and all spoke English as their mother tongue. Children were allocated randomly to treatment groups with the qualification that five boys and five girls were placed in each group.

RESULTS

The experiment has a crossed and balanced two-factor (sex and treatment) design, with a single covariate (teachers' rankings). A parametric analysis of covariance would generally be used to test hypotheses about the treatments, the sexes, and their interaction. The obtained scores, however, did not fit the assumption of normality which is made in the parametric analysis: the reading scores (errors) formed a bimodal distribution, and the covariate, being ranks, was distributed rectangularly. Therefore it was more suitable to use a non-parametric analysis. Quade (1967) developed a suitable test for single-factor experiments, but no two-way test appears to exist. Quade (personal communication) has expressed doubt that such a test is possible, because of the difficulty in giving meaning to the interaction term.

Therefore, the scores for boys and girls were first analysed together, using Quade's test. In the test all scores, covariate and dependent measure, are first ranked. The dependent measure ranks are then adjusted on the basis of the covariate, and given an overall mean of zero. Thus, the more negative the adjusted rank of a child the better his performance. The mean of the adjusted ranks is found for each group, and also a critical ratio (VR), analogous to the F ratio in parametric analysis. The critical ratio is distributed as chi-square on one degree of freedom, under H_0. Table 1 shows the mean adjusted ranks for the two treatment groups, and the critical ratio with its associated probability for both sound blending and reading for the total group.

TABLE 1

ANALYSIS OF SOUND BLENDING AND READING PERFORMANCE BY TREATMENT GROUPS.

Variable	Mean Adjusted Rank		Critical Ratio (VR)	P<
	Group 1	Group 2		
Sound blending	−1·50	1·50	2·83	·05
Reading	−1·30	1·30	4·00	·05

The direct instruction given to Treatment Group 1 produced performances superior to the Treatment Group 2, on both sound blending and reading.

To see whether there was any main effect difference between the sexes, the scores were analysed again by Quade's method, this time with the sexes separated but treatment groups combined. The results are shown in Table 2.

TABLE 2

ANALYSIS OF SOUND BLENDING AND READING PERFORMANCE BY SEX.

Variable	Mean Adjusted Rank		Critical Ratio (VR)	P<
	Boys	Girls		
Sound blending	−0·30	0·30	0·12	NS
Reading	−0·44	0·44	0·39	NS

Differences between sexes did not approach an acceptable significance level on either sound blending or reading.

The results shown in Tables 1 and 2 give information on the effects of the treatments and of sex separately. Some information on the interaction of these two variables, even using a one-factor method of analysis, may be obtained by analysing the effects of the treatments for each sex separately. The results of these analyses are given in Table 3.

TABLE 3

ANALYSIS OF SOUND BLENDING AND READING PERFORMANCES BY TREATMENT GROUP AND SEX

Variable	Sex	Mean Adjusted Ranks		Critical Ratio (VR)	P<
		Group 1	Group 2		
Sound blending	Girls	−0·29	0·29	0·14	NS
	Boys	−1·65	1·65	6·04	·05
Reading	Girls	−0·17	0·17	1·06	NS
	Boys	0·98	0·98	3·31	NS

The results given in Table 3 show that the boys are significantly more responsive than girls to the treatment on sound blending, but that they are only slightly more responsive as far as reading is concerned. Both boys and girls have their reading performance improved by the experimental treatment (though not significantly, in the statistical sense, when their results are analysed separately), but girls' sound blending performance is hardly improved at all by the experimental treatment.

EXPERIMENT TWO

Material.

The material used was the same as for Experiment I, with the addition of the Clymer-Barrett Prereading Test of Visual Discrimination, the score on which was used as a covariate, (Clymer and Barrett, 1969).

Procedure.

A third covariate, age, was introduced.

Except that children were given four, not six, trials on the eight CVC words in the reading programme, procedure was the same as for the first experiment.

Sample.

20 boys and 20 girls were selected randomly from two neighbouring kindergartens. Their ages ranged from 4·04 to 5·03 years, with a mean of 5·00 years. The children were allocated to treatment groups so that there were 10 boys and 10 girls in each, and children from one kindergarten counterbalanced those from the other.

Data were analysed using Quade's (1967) one-way rank analysis of covariance, the covariates being age, Clymer-Barrett Prereading Test score, and teacher's ranking on predicted reading ability.

TABLE 4

ANALYSIS OF SOUND BLENDING AND READING SCORES BY TREATMENT GROUPS.

Variable	Mean Adjusted Rank		Critical Ratio (VR)	P<
	Group 1	Group 2		
Sound blending	−3·23	3·23	3·75	·05
Reading	−1·94	1·94	1·24	NS

Direct instruction to Treatment Group 1 produced results on sound blending which are superior to Treatment Group 2.

Table 5 shows the mean adjusted ranks of boys and girls, combining treatment groups, on the two tests.

TABLE 5

ANALYSIS OF SOUND BLENDING AND READING PERFORMANCE BY SEX.

Variable	Mean Adjusted Rank		Critical Ratio (VR)	P<
	Boys	Girls		
Sound blending	−3·42	3·42	4·28	·05
Reading	1·19	−1·19	0·42	NS

There was a significant difference between boys and girls on the sound blending task, but, contrary to expectation, when both treatment groups were combined, boys were superior to girls. The results of the reading test show no significant sex difference.

To assess interaction between treatment and sex, data were analysed separately for boys and girls, assuming that the covariates were distributed in the same way across sexes. The discrepancies between the two sets of results are shown in Table 6.

TABLE 6

ANALYSIS OF SOUND BLENDING AND READING PERFORMANCES BY TREATMENT GROUP AND SEX.

Variable	Sex	Mean Adjusted Ranks		Critical Ratio (VR)	P<
		Group 1	Group 2		
Sound blending	Girls Boys	−2·67 −0·55	2·67 0·55	6·90 0·24	·02 NS
Reading	Girls Boys	−2·17 0·13	2·17 −0·13	4·47 0·01	·05 NS

The girls' responses contributed more to the differences between treatment groups than did the boys' responses. This was true for both sound blending and reading. These interaction effects are more marked for the kindergarten children than for the preparatory grade children. The preparatory grade children are about a year older than the kindergarten children.

DISCUSSION

Positive findings, whose implications deserve discussion, are summarised below:-

Sound blending post-test

(i) Trained kindergarten and preparatory grade children performed better than untrained children;

(ii) Trained kindergarten girls performed better than trained kindergarten boys;

(iii) Trained preparatory grade boys performed better than trained preparatory grade girls.

Reading post-test

(i) Preparatory grade children given sound blending training performed better than preparatory grade children not given sound blending training;

(ii) Kindergarten girls given sound blending training performed better than kindergarten boys given sound blending training.

These findings imply that language processing skills can be taught systematically, and at an early age. In addition, training in such skills facilitates learning to read, though in these experiments this result did not appear at quite such an early age. The kindergarten group showed only a non-significant difference, albeit in the same direction.

The finding of sex-treatment interaction is particularly interesting. The predicted blanket effect of female superiority in language skills was not found. Instead a pattern of highly specific differences emerged, suggesting that kindergarten girls were differentially able to profit from training in sound blending, to their advantage on post-tests of both sound blending and reading. By contrast, the preparatory grade boys profited more than girls in the same grade from training in sound blending. These results are consistent with the view that there is about one year's difference in readiness to begin learning to read; that is, that girls are ready to begin learning to read about one year earlier than boys. However, this interpretation is almost certainly too gross. If it were adequate the advantage of the girls might be due to broadly different and non-specific experiences and training. In this study this was not the case. Rather the evidence is that the girls were advantaged because of highly specific training. Only the kindergarten girls given training in sound blending performed better than boys of the same age given the same training; girls without this training had no such advantage.

The sound blending training was auditory only. Association of sound and symbol (letter) was established as part of the reading programme. For the preparatory grade children the sound-symbol association was essentially revision of learning already undertaken; for the kindergarten children it was new learning, which may account for the finding that kindergarten children trained on sound blending did not perform significantly better on reading than untrained children of the same age.

We conclude that the sound blending training, with its transfer effect to reading performance, was effective because it was based on auditory processing skills already learned at an automatic level. That is, the spoken language, familiar to children, provides a system through which they can learn to recode the written language back to speech. A large number of language processing skills is almost certainly involved in learning to read; our evidence indicates that sound blending is one. Others which deserve empirical scrutiny are grammatical sequencing, rhyming, auditory memory span, auditory sequencing, visual memory span, visual sequencing, and a set of visual discrimination skills.

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THE DISTRIBUTION OF PIAGETIAN STAGES OF THINKING IN BRITISH MIDDLE AND SECONDARY SCHOOL CHILDREN

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SUMMARY. The proportion of children showing early and late concrete operational thinking, and early and late formal operational thinking was measured in a sample of 10,000 children between the ages of 9 and 14. The test instruments were a form of group test called Class Tasks, derived from the individual interview situations described by Piaget. These tests indicated that most children in early adolescence showed rapid development in concrete thinking, but that only one-fifth of the children showed the further development of formal operational thought. The representativeness of these findings was ensured by relating the distribution of Piagetian stages at each age-level to the norms of a standardised non-verbal reasoning test.

INTRODUCTION

As part of a study of the conceptual demands made in school mathematics and science curricula (CSMS project), it was thought desirable to know how the levels of thinking which Piaget describes are distributed in the school population. Do all children go through the stages described in *The Growth of Logical Thinking* (Inhelder and Piaget, 1958) at the ages mentioned there? The follow-up study of Lovell (1961) confirms the unity of Piaget's description, but was made on far too few children to show the population change year by year. Work by Tisher (1971) and Karplus (1975) suggests that the only economical way of testing the number of children required is to develop a test instrument which can be administered to the whole of a school class at a time.

The population initially chosen was that of the first three years of secondary education (11 to 14), but this age-range was extended to include 9 and 10-year-old children, because of the current interest in science for middle schools. In order to sample the whole range of thinking to be found in such a wide age-range it was necessary to develop measurement techniques from pre-conceptual thinking right through to late formal operational thinking. For this purpose three tasks were devised: the first covered pre-conceptual thinking (Stage 1) through to late concrete operational (2B); the second from early concrete (2A) to early formal (3A), and the third from late concrete (2B) to late formal (3B). The validity of each task was established by ensuring that each item had its counterpart in one of the original clinical interview situations described by Piaget and his co-workers.

DESCRIPTION OF TASKS

Task 1: This was based on *The Child's Conception of Space* (Piaget and Inhelder, 1956). Four situations are taken, and each may be scored at a number of levels characteristic of performance.

(*a*) An empty jam-jar is held up and each pupil is asked to draw it in cross-section, imagining it half-full of water. Then it is tilted to 45°, and the pupil asked to draw it as it would look if it were still half-full of water. Finally, it is held horizontally, and the same question asked.

(*b*) The children are asked to draw the outline of a mountain, and on its side draw a house and some trees.

(*c*) A jam-jar with a plumb-line hanging inside is provided for each child, who is asked to handle it. Then the same questions are asked as in (*a*).

(*d*) The child is asked to imagine that he is standing in the middle of a long straight road going away into the distance, and either side of it are rows of trees. He is asked to draw it as it would look.

Depending on the item scores an overall assessment on this task can range from pre-conceptual through to late concrete (2B), with an additional scoring of 2B+.

Task II: This was based on *The Child's Construction of Quantities* (Piaget and Inhelder, 1974), and was chosen as being particularly suitable for the range of measurement 2A to 3A. Unlike Task I, Task II is hierarchically organised, with each item scored right or wrong. There are 16 items, of which the first two are the classical water-pouring tests from Chapter 1 of *The Child's Conception of Number* (Piaget 1952) and the next is a substance-conservation question based on maize being 'popped' in front of the class. These three items test conservation of substance, an early concrete operational concept (2A). The next seven are all scored as late concrete (2B) items, and involve intuitive density and water-displacement concepts based on a block of plasticine being lowered into water in measuring cylinders, and then distorted in various ways. Then there is a 2B/3A item in which pupils are asked to hold a block of brass and a block of plasticine of the same dimensions, and asked how the amount of water they would displace would compare. Finally, there are three 3A items requiring an analytical concept of density for their solution.

Task III: This was based on Chapter 4 of *The Growth of Logical Thinking* (Inhelder and Piaget, 1958), also using Somerville's more detailed description of performances on the pendulum problem (Somerville, 1974). Task III has 14 scored items, again scored right or wrong, and each labelled 2B, 3A or 3B. On both this and Task II the overall assessment principle is to ask for success on at least two out of three of the items characteristic of a stage, or sub-stage. A simple pendulum is demonstrated, and the values which possible variables could take are dichotomised : long or short ; light or heavy ; gentle or hard push. Two readings are taken in front of the class of the number of swings the pendulum makes in 30 seconds; the values taken are such that from the two readings no clear deductions can be made. The children are then challenged to make deductions. Then follow four items scored at the 3A level, in which, given the first two readings, the children are asked to say what combinations they think they should take next in order to decide about the effect of length, weight, and push, respectively. Finally, two more readings are added to the first two, from which the effect of length and weight can be deduced, and also, with difficulty, that of push. The 3B items are obtained by asking the children to choose the right strategy by which to make these deductions.

VALIDITY OF THE TASKS

Since the criterion of validity chosen is the match of the task with the original Piagetian research, it seemed best to obtain a measure of it by comparing how the same children performed in the Class-Task situation, and in the original clinical interview from which the task items were taken. Professor Lovell, of Leeds University, kindly agreed to make a small-scale comparison in respect of

Tasks I and II; the CSMS team, with advice from Susan Somerville, made a larger-scale comparison on the Pendulum.

Task I. Seven children who had done the Class-Task were interviewed in their school by Professor Lovell, three-and-a-half months later, following the procedure outlined in *The Child's Conception of Space* (pp. 171, 173, 381-382). There were four interview items matching the four task items for each child, making 28 comparisons in all, together with a 'Points of View' item, which could be compared with the overall result on Task I. For these 35 comparisons a product-moment correlation of 0·85 was obtained.

Task II. The interview was based on *The Child's Construction of Quantities* (pp 4, 47-48, 119, 234, 258, 259). As it was rather lengthy, only four children were interviewed by Professor Lovell, about three months after they had done Task II. In three cases the Class-Task and interview item assessments were as close as in Task I, but the fourth case, a less able girl aged 13, shown as 2A or less by Task II, was given an overall assessment of 2B by interview, during which she appeared to have learned.

Task III. The interview and its assessment was based on Somerville's (1974) procedure. 54 boys and girls were interviewed six to eight weeks after they had done Task III. In this case the product-moment correlation was only 0·51. Task III had a 3B criterion based upon Piaget's analysis (Inhelder and Piaget, 1958, pp. 67-76): the interview had a lower criterion based on the children's responses, and this led to a systematic difference in assessment. Yet when the Friedman two-way analysis of variance was used to compare the results of the same children on Task II and Task III (Siegel, 1956, p. 166), although there were 22 cases of higher ranking by Task III than Task II, the probability that the two tasks were ranking the child alike was 0·8 ($\chi^2=0{\cdot}36$, N=333).

METHOD

Sample.

To obtain representative distributions of Piagetian stages in a British child population it was necessary to choose schools from a wide variety of areas, and to ensure that the sample of schools provided an appropriate proportion of children at different ability levels. Although the development and standardisation of the tasks used was done in London comprehensive schools, the one type of school absent from the survey was the large metropolitan comprehensive. 46 schools were used: four comprehensives in the Cardiff area, seven comprehensives in rural and city Gloucestershire, six small comprehensives in Hertfordshire; three comprehensives in rural and city Lincolnshire, and one comprehensive in each of Manchester, Staffordshire, Nottinghamshire and Southampton. 13 middle schools in the Leeds area were used for the 9- and 10-year-old children. To ensure adequate representation of the top 20 per cent of the ability range, and because of their interest as a separate population, nine selective schools were used: one each from Cambridge, Surrey and Nottinghamshire, and six in the London area. Each school was asked to ensure, as a minimum requirement, that every class in at least one year-group should be tested. The aim was to obtain for each year-group 1,200 children with complete data; to do this an initial sample of some 2,000 for each year-group was chosen, giving an overall total of about 10,000 children. The ability range of each school was measured by administering the Calvert Non-Verbal reasoning test (Calvert,

1958) to the whole of the 11+ year of the school (or to the 12+ year if that was not possible). (This test was chosen because it seemed to have, of the available tests of intelligence, most in common with what the Class Tasks were testing, and this is borne out by the correlations). Since this test has been standardised by the NFER on a substantial representative sample of British children to a mean of 100 and standard deviation of 15, comparison with this norm provided an indication of the representativeness of the sample used here.

Procedure for testing.

Although each task had full written instructions for administration and assessment, every school was visited by a member of the CSMS team for briefing on the tasks: where possible the task was demonstrated to the whole science department ; otherwise it was demonstrated to the head of science who then briefed his department. Testing was carried out in the academic year 1974-75. To avoid making an unreasonable demand on a school, only one task was administered in each term (in the autumn term, the Calvert Non-Verbal test was also given), and the team undertook, on each occasion, to keep within the bounds of a double-lesson (about 50 minutes). The class teacher demonstrated the problem and asked all the questions orally ; the questions were also printed on the pupil's response sheet. Pupils were allowed to ask questions to make sure they understood what they were being asked and the teacher was encouraged to make sure his pupils did understand, and to talk through the question with individual pupils if necessary. Wherever possible the answer could be made by drawing, or by ticking a right answer from a choice of possible ones. Finally, the teacher assessed the pupils' responses according to a schedule provided.

This test situation thus has some of the features of the interview, and some of the features of a psychometric test : the term ' Class-Task ' was coined to describe its difference from both interview and test. In this approach the teacher's skill, and his experience of his class, are used to make sure that the test situation is clearly understood. Accuracy of assessment was approached by a number of checks. For each class there was a 10 per cent check by a member of the CSMS team. If there were two or more differences in the assessment of an item in the response sheets of any three of the pupils, all of that class's response sheets were re-assessed. If it was clear from the pupils' responses that the test had been faultily administered or that the teacher had influenced the pupil's responses, that class's results were not used. Very few classes had to be omitted. Later all the assessments were recalculated from the item scores after item-analysis had shown that slight changes in the scoring-rules were needed.

RESULTS

Since there were only a few schools able to provide children from several years, each year-group was examined separately. For each school the Calvert mean standardised score, and the percentage of children at each Piagetian level assessed by a task was calculated. The regression line of task level percentage on Calvert mean was used to allow every measurement to contribute to the population estimate, and the level percentage corresponding to a Calvert mean of 100 was taken as representative. A check was made that this gave the same result as taking a group of schools with a combined Calvert mean of 100 and standard deviation of 15. The results for the three tasks are given in Tables 1, 2 and 3.

TABLE 1

PERCENTAGE OF CHILDREN AT DIFFERENT STAGES BY TASK I.

Child population		Stage of performance in Task I				
N	Mean age of children	1	2A	2A/2B	2B	2B+
1089	13 years 8 months	0·4	0·7	5·9	44·4	48·5
2209	12 years 8 months	1·5	3·8	16·0	45·7	33·0
2173	11 years 9 months	3·2	8·3	28·6	40·4	19·5
1132	10 years 8 months	8·2	12·4	33·0	36·6	9·8
831	9 years 8 months	11·0	17·0	36·2	28·2	7·7

TABLE 2

PERCENTAGE OF CHILDREN AT DIFFERENT STAGES BY TASK II.

Child population		Stage of performance in Task II					
N	Mean age	1	2A	2A/2B	2B	2B/3A	3A
1238	14 years 1 month	0·7	3·4	14·2	28·1	29·8	23·8
2094	13 years 1 month	3·4	5·8	21·0	29·3	26·3	14·2
1727	12 years 1 month	4·2	7·9	23·6	30·2	25·8	8·3
1157	11 years 1 month	7·3	13·8	36·0	27·2	10·1	5·6
765	10 years 0 months	11·6	16·9	36·8	25·2	7·4	2·2

TABLE 3

PERCENTAGE OF CHILDREN AT DIFFERENT STAGES BY TASK III.

Child population		Stage of performance in Task III				
N	Mean age	2B—	2B	2B/3A	3A	3B
1305	14 years 4 months	29·4	25·2	23·6	14·8	7·1
1543	13 years 4 months	35·3	23·8	23·1	14·1	3·8
1292	12 years 3 months	40·1	20·5	25·4	12·6	1·5

TABLE 4

PERCENTAGE OF SELECTIVE SCHOOL CHILDREN AT DIFFERENT STAGES.*

	Child Population	Stage of performance in Task II				
N	Mean Age	2A/2B	2B	2B/3A	3A	3B
249 (159)	14 years 2 months	1·2	6·4 (0·6)	28·5 (13·2)	63·8 (86·2)	— —
150 (146)	13 years 2 months	2·0	8·0 (2·1)	34·7 (11·0)	55·3 (87·0)	—
430 (217)	12 years 2 months	9·0 (0·5)	18·3 (12·0)	39·0 (31·3)	33·6 (56·2)	— —
		Stage of performance in Task III				
146 (135)	14 years 3 months	5·2	8·8 (2·9)	21·8 (11·6)	40·9 (27·3)	23·3 (58·1)
134 (157)	13 years 3 months	9·2 (1·0)	14·7 (2·0)	32·6 (16·8)	30·4 (34·2)	13·0 (46·0)
321 (266)	12 years 4 months	8·1 (3·4)	15·9 (7·5)	36·4 (28·2)	24·0 (34·2)	15·6 (26·7)

* Details for the ' super-selective ' sample are shown in parentheses.

In Table 4 there are two sets of results for the selective school population. Three of the schools are known nationally, and their pupils figure in the Oxbridge scholarship tables: their results are amalgamated separately, and given in parentheses. It is estimated that the population of these schools represents the top 8 per cent of the ability range. The other six schools were good grammar schools taking approximately the top 20 per cent of the ability range and their amalgamated figures are quoted as representative of the average English grammar school.

TABLE 5

CORRELATIONS BETWEEN TASKS AND CALVERT TEST, BETWEEN DIFFERENT TASKS, AND RELIABILITY ESTIMATES.

	Calvert Test	Task II	Reliabilities
Task I	0·60	0·41	0·82
Task II	0·55	—	0·80
Task III	0·63	0·57	0·86

Correlation coefficients and reliabilities are given in Table 5. The Task II and III reliabilities were calculated by KR-20, and for Task I by Hoyt's analysis of variance (Winer, 1970, pp. 124-128). Both the correlations and reliabilities were calculated on samples of between 300 and 400, and the age variable was largely eliminated by using only one year-group for each.

DISCUSSION

In order to show the overall pattern of development in the child population studied the results are plotted in Figures 1, 2 and 3, in the form of cumulative percentages. A point showing 50 per cent of the population of that age as 2B should be read as 50 per cent at that level or above. In the population as a whole the development of early formal thinking seems to be confined to the top 20 per cent of the year-group; when the top 20 per cent are looked at separately, most of their development has already taken place by age 14½. Thus, any rise in the proportion of young people beyond the age of 14 showing early formal performance must come from that part of the population which lies below this top group. Until the next two year-groups in the secondary school have been studied it will not be possible to read these curves unequivocally, but many teachers with comprehensive school experience would be surprised if development did not continue, at least for that part of the population between the 80th and the 50th percentile of ability, well up to 17 years of age. It is intended to compare these results with analyses of the apparent conceptual demand of science and mathematics curricula in an attempt to throw light on some of the learning problems of secondary and middle school children.

FIG 1

Proportion of Children at Different Piagetian Stages in a Representative British Child Population.

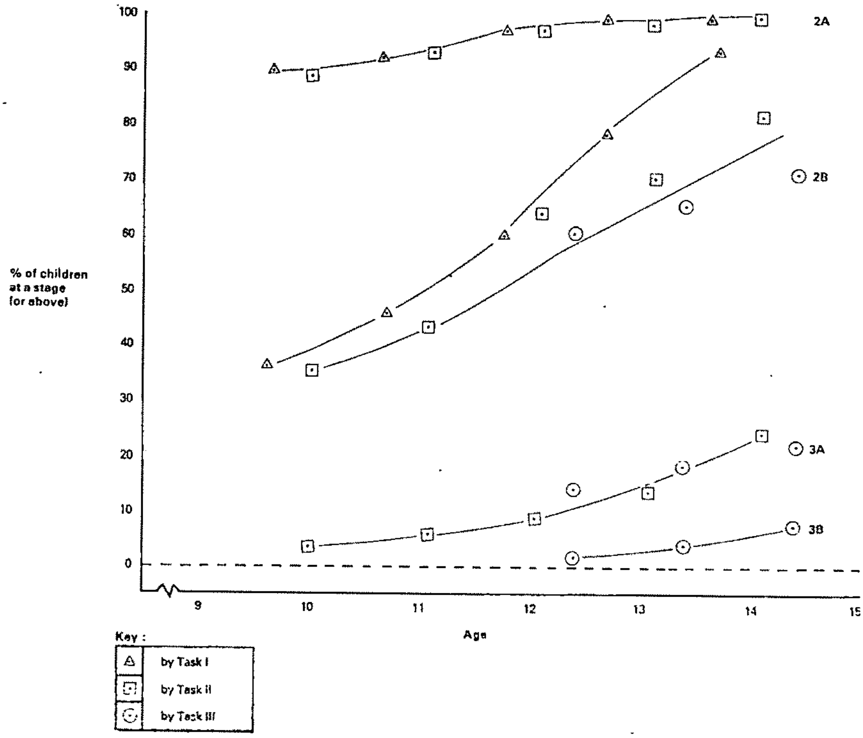


FIGURE 2

SELECTIVE SCHOOL POPULATION (TOP 20%).

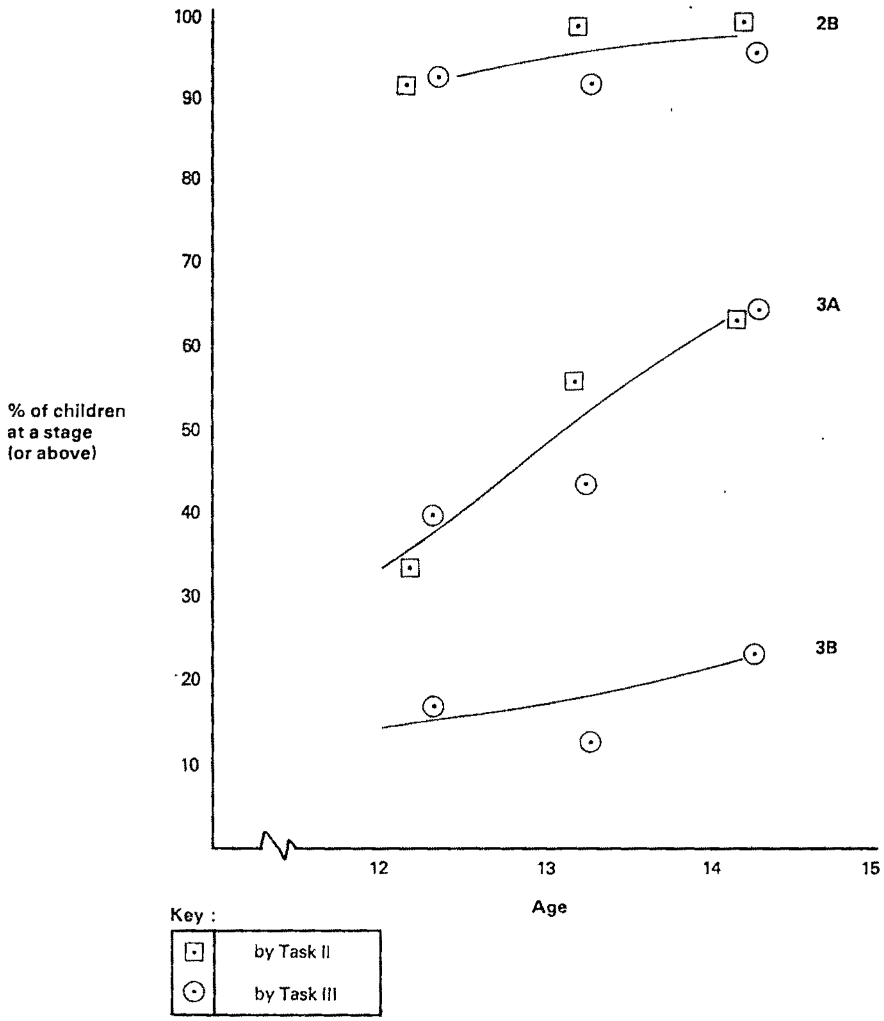
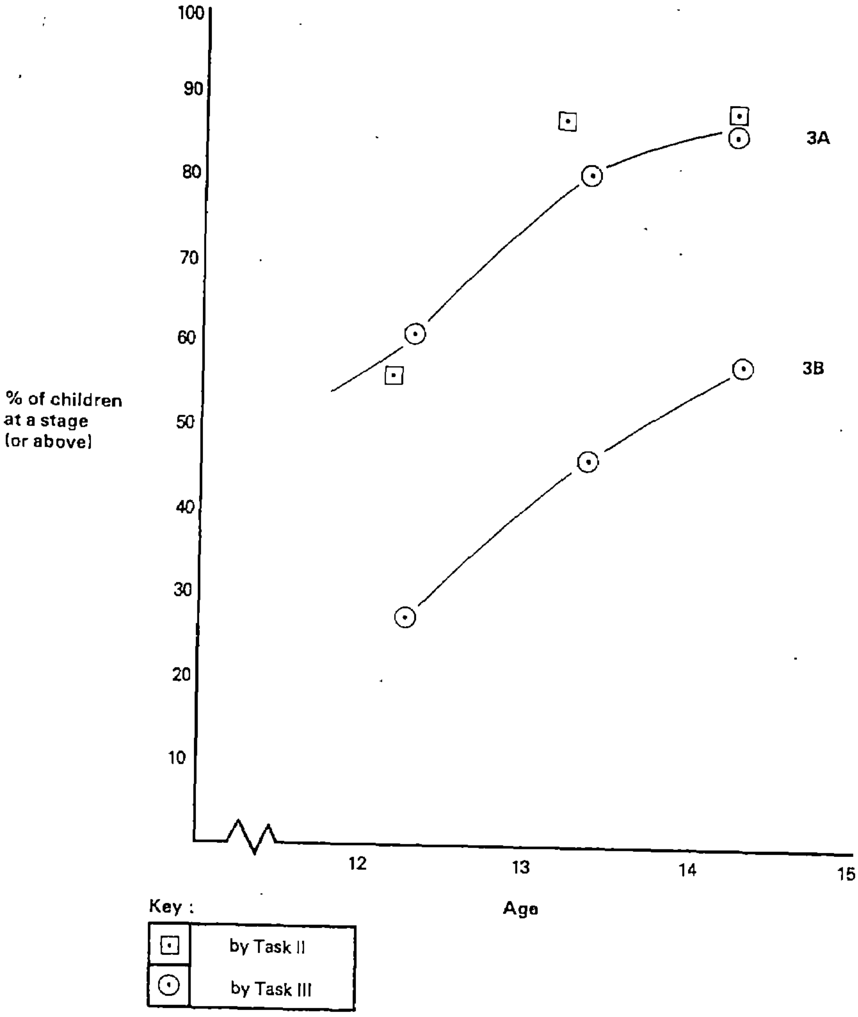


FIGURE 3

SUPERSELECTIVE SCHOOL POPULATION (TOP 8%).



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ASSOCIATIVE STRUCTURE OF SCIENCE CONCEPTS

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SUMMARY. The structures underlying the continued word associations to 15 concept words drawn from mechanics were investigated in samples (N=20) ranging from secondary school first-formers to university science graduates. Substantial re-test stability of group structures was established and comparison of the structures with various theoretical schemes showed that a hierarchical model was a good representation for those knowledgeable in physics.

INTRODUCTION

THE importance of subject-matter structure in education has been emphasised by Schwab (1962), Ausubel (1963), and Bruner (1966), and it has been a recurring theme in discussions of the content and organisation of new science curricula (Shulman and Tamir, 1973). For example, the Schools Council Integrated Science Project is entitled *Patterns* and the underlying theme is the understanding of the pattern of relationships among concepts (Hall, 1973).

Shavelson (1974) has listed the reasons which have been given for this increasing emphasis on subject-matter structure: knowledge of structure is necessary for a full understanding of a subject, it enhances retention, facilitates problem solving, leads to transfer, results in intellectual excitement, and develops an aptitude for learning. Shavelson noted, however, that there was little empirical evidence to support these reasons, and he suggested the need for research, in the first place, into the acquisition of cognitive structure—the organisation of concepts in memory—and its relationship with subject-matter structure. The present investigation was concerned with just this issue: the development of cognitive structure during the years of learning a subject and its relationship with the pattern of concepts that constitutes the content of the subject (in this case, classical mechanics). Moreover, exploring the development of cognitive structure should provide answers, in a particular subject area, to the two questions concerning the analysis of progress in learning posed by Michon (1972): how do the internal representations of external structures develop and what distinguishes the experts' cognitive structures from those of the pupils?

Deese (1965) was among the first to use the word association test as a means of investigating cognitive structure. He defined the associative meaning of a stimulus word as the distribution of single free responses obtained from a group of subjects, and he claimed that although this was only a subset of the set 'meaning,' it was the largest possible subset obtainable by any single technique. It followed that associative structure—the pattern of interconnections among associations—was a major aspect of cognitive structure. Defined in this way, associative meaning is a property of a group and not of an individual, but the continued word association test, in which each subject provides a number of associations to the stimulus word, enables the determination of a comparable associative meaning for an individual.

Deese (1965) has argued that the free association test, coming closer than any other technique to being context free, is the proper instrument with which to begin the study of verbal organisation in thought. In particular, he has pointed out its advantages, in studies of the formation of scientific concepts, over the more conventional problem-solving approach which is contaminated by the effects of arithmetical competence and by rote memorisation of examples. Moreover, Johnson (1969) has noted that a problem-solving test is not sensitive to an individual's knowledge of concepts that cannot be expressed as a solution sequence and that such tests are quite inappropriate for individuals who have no formal experience of the subject matter, and he has argued that the word association test does not suffer from these disadvantages.

The group associative structure of six mechanics concepts for college physics students was investigated by Johnson *et al.* (1970) and found to be well represented by a spatial model in which the associative similarity of concepts was represented by the proximity of the corresponding points in a three-dimensional semantic space. The model was derived on the assumption that subjects related the six concepts in terms of operations involving the concepts MASS, DISTANCE, and TIME. In another study, however, Johnson *et al.* (1971) showed that a hierarchical model, in which the concepts MASS, DISTANCE, and TIME formed the base from which the hierarchy was constructed, was also a good representation of associative structure (for university physics students); and Preece (1976) has shown that yet another model—a graph or network based on the same triad of basic concepts—is also a good representation of the associative structure in this domain (for university physics graduates).

MASS, DISTANCE, and TIME were selected as the basis of these models of associative structure because of their supposed operational, or ostensive, character. It is plausible to suppose that more complex (relational) concepts are built from simpler, and ultimately from ostensive, ' point-at-able,' concepts (Gagne, 1970). But models based upon other triads of fundamental concepts are possible, and the investigation reported here involved the comparison of several spatial, hierarchical, and graphic models with empirical data on associative structure. Moreover, by investigating the associative structures of groups ranging from secondary-school first formers to university science graduates, an attempt was made to explore the crystallisation of the structures from the concrete, intuitive, and isolated concepts of childhood.

Models of associative structure.

The 15 mechanics concept words are shown in Table 1 together with the symbols used to represent them. The concepts are all interrelated by means of equations of the form $\mathbf{w}=\mathbf{y}\times\mathbf{z}$. (E.g., $\mathbf{m}=\mathbf{V}\times\mathbf{d}$, $\mathbf{A}=\mathbf{L}\times\mathbf{L}$, $\mathbf{F}=\mathbf{m}\times\mathbf{a}$, $\mathbf{P}=\mathbf{F}\times\mathbf{v}$, etc.) Three further identity relations were also assumed ($\mathbf{u}=\mathbf{v}$, $\mathbf{F}=\mathbf{G}$, $\mathbf{W}=\mathbf{E}$).

TABLE 1

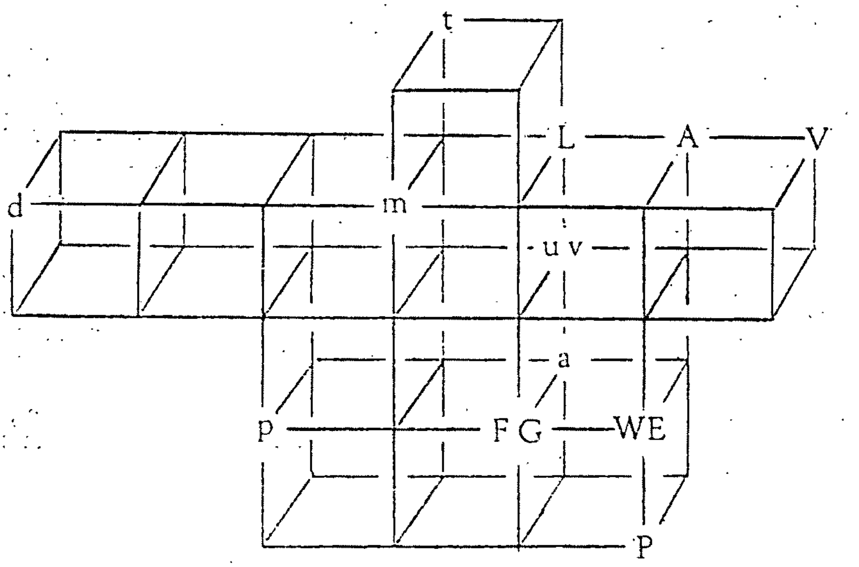
THE FIFTEEN MECHANICS CONCEPTS.

Concept	Symbol	Concept	Symbol
DISTANCE	L	TIME	t
AREA	A	SPEED	u
VOLUME	V	VELOCITY	v
MASS..................	m	WEIGHT	G
DENSITY	d	PRESSURE	p
ACCELERATION	a	WORK	W
FORCE	F	ENERGY	E
		POWER	P

Dimensional analysis (Bridgman, 1931) was used to derive spatial models representing the relations among the concepts. Taking mass, distance, and time as basic quantities, as in the International System of Units (SI), the dimensions of the 15 concepts were determined, the results being interpreted as the co-ordinates of the concepts in a three-dimensional space. This **mLt** spatial model is illustrated in Figure 1. The basic units of SI owe something of their status to the ease with which they can be operationally defined and so are plausible candidates for the fundamental concepts which define the axes of semantic space.

FIGURE 1

THE **mLt** SPATIAL MODEL.



Winans (1972) has suggested, however, that mass cannot be directly perceived as a sense impression but requires the perception of force and that it is therefore more sensible to use force, distance (more strictly, displacement), and time as basic quantities. For this reason, a spatial model of associative structure was developed from the dimensions of the concepts based on force, distance, and time as basic quantities (**FLt** model). A third spatial model based on density, distance, and velocity as basic quantities (**dLV** model) was also developed. Both velocity (in terms of overtaking) and density (in terms of flotation) can be ostensively defined.

Three further models were constructed by building hierarchies of concepts based on each of the triads of ostensive concepts noted above. Each relational concept required two defining concepts, and this is illustrated in Figure 2 which shows the **mLt** hierarchical model.

Finally, three graphic models were constructed by collapsing each of the hierarchical models so that the ostensive concepts occurred at only one point on the graph. This is illustrated in Figure 3 which shows the **mLt** graphic model.

FIGURE 2

THE mLt HIERARCHICAL MODEL.

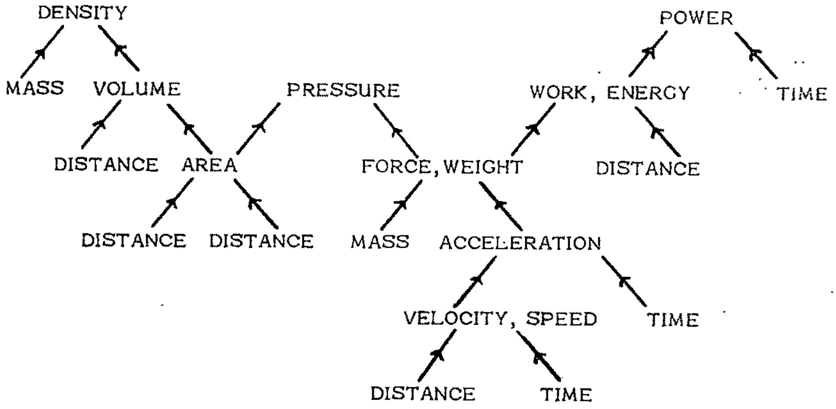
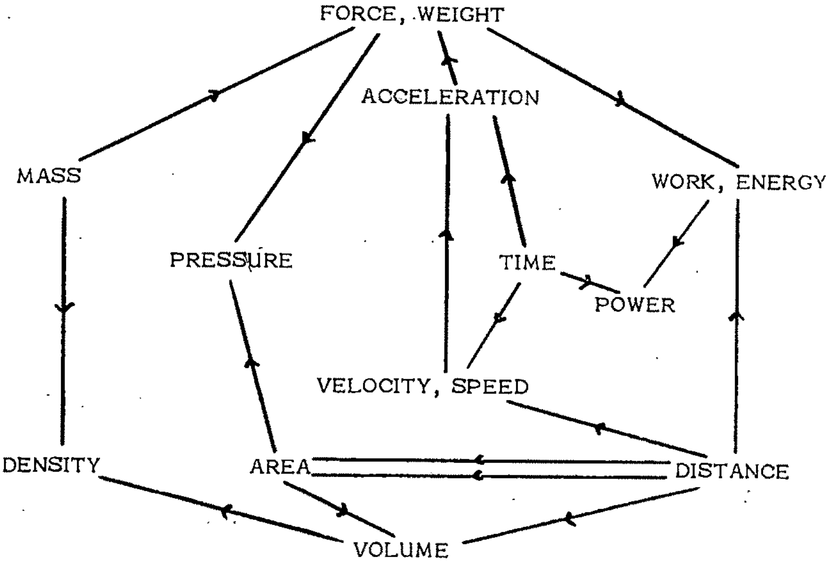


FIGURE 3

THE mLt GRAPHIC MODEL.



The empirical data on associative structure concerned the relative proximities of concepts, and so for purposes of comparison it was necessary to derive from the theoretical models the distances apart of all the concepts in the set. The spatial models yielded such distances directly, and for the hierarchical and graphic models, the distance between concepts was taken as the smallest number of steps separating them. In this way, half-matrices of inter-concept distances were derived for each model.

METHOD

Samples

Five groups of 20 students were investigated. The school groups comprised students, all of whom were taking physics, from a boys' maintained grammar school. The university groups were graduate certificate in education students, and the members of the science group had all graduated in physics or a closely related subject. Table 2 lists the groups and gives the mean age at the first test.

TABLE 2

THE GROUPS TESTED

	Group	Mean age (years—months)
A	First form	12–3
B	Fourth form	15–4
C	Sixth form physics	18–2
D	University science graduate	23–6
E	University non-science graduate	23–0

Procedure

The 15 concept words listed in Table 1 were the stimuli in the continued word association test given to all subjects. Each stimulus word appeared underlined at the top of its page in the test booklet and 10 times down the side of the page. This repetition of the stimulus word was intended to reduce chaining by encouraging the subjects to return to the stimulus after each association. During assembly, the pages containing stimulus words were shuffled in order to reduce systematic effects due to priming, decreasing motivation, and fatigue.

On the front page of the test booklet, subjects recorded their names and dates of birth. The second page contained the test instructions which all subjects read on completing page one. The instructions explained that hearing or seeing a word often makes people " think of other words " and that the object of the test was to find the words " brought to mind by some words used in science." The instructions emphasised the importance of going back to the stimulus after each association and explained that there were no right answers and that spelling mistakes did not matter.

After reading the instructions, subjects turned to the next page which contained an example giving continued associations to the word ELECTRICITY. This example was described to the subjects and the following points were emphasised:

(i) The importance of avoiding chaining.
(ii) The use of single-word responses, not phrases.
(iii) The avoidance, if possible, of repetitions of the same response on one page.
(iv) Responses were not limited to ten—further associations were to be written down the side of the page.

Any questions concerning the test were then invited; these did not reveal any major misunderstanding. Subjects were then reminded to work quickly and told to turn to the next page and begin. At one minute intervals the instruction to turn over was given until the test was completed.

Although this was a free word association test, responses not being constrained to any particular categories, an attempt was made to induce a scientific set. The test was called a scientific word test, the school subjects were tested in physics laboratories, and the science graduates were also tested as physics groups. All subjects were asked to treat the test seriously and to avoid the habit of giving merely frivolous responses. It was explained to the university subjects that the test was concerned with the use of words and was not being used as a means of tapping the unconscious mind.

In order to investigate the stability of the associative structures, groups A, B, and C were retested after an interval of between four and 10 weeks. The original tests were before either the Easter (group C) or the summer holidays (groups A and B) and the retests were immediately after the holidays. This procedure ensured that subjects had not received further instruction in physics between the tests.

RESULTS

Empirical matrices.

A half-matrix of overlap coefficients, giving the overlap between every pair of response hierarchies, was calculated for each subject. Garskof and Houston's (1963) relatedness coefficient was used as the measure of overlap, with the parameter, p, given the value 1, which yielded a coefficient in which greater weight was given to earlier responses.

From the individual half-matrices of inter-concept proximities, an average half-matrix was calculated for each group. In the group half-matrices, each entry was the mean value of the corresponding cell entries in the individual half-matrices of the subjects in the group.

Matrix correlations.

Correlating the corresponding entries in two matrices provides a measure of their structural similarity, and the procedure adopted consisted of first ranking the 105 cell entries and then calculating the product-moment correlation between paired ranks.

The stabilities of the structures in the group matrices were measured by correlating those obtained on test and retest for the three school groups. The resulting correlations for the overlap coefficient half-matrices were 0·810 for group A, 0·919 for group B, and 0·923 for group C.

The group overlap coefficient half-matrices were correlated with the nine theoretical half-matrices of inter-concept distances, and the results are given in Table 3. The results for groups A, B, and C refer to the initial test. As was expected, all the correlations between proximities and distances were negative.

TABLE 3

CORRELATIONS BETWEEN THEORETICAL AND EMPIRICAL HALF-MATRICES.

	Spatial Model			Hierarchical Model			Graphic Model		
Group	mLt	FLt	dLv	mLt	FLt	dLv	mLt	FLt	dLv
A	–0·204	–0·066	–0·255	–0·297	–0·309	–0·371	–0·278	–0·214	–0·342
B	–0·347	–0·290	–0·326	–0·616	–0·608	–0·671	–0·583	–0·561	–0·605
C	–0·397	–0·237	–0·256	–0·712	–0·644	–0·687	–0·672	–0·613	–0·599
D	–0·430	–0·237	–0·299	–0·671	–0·606	–0·675	–0·662	–0·640	–0·621
E	–0·323	–0·212	–0·325	–0·413	–0·427	–0·513	–0·401	–0·399	–0·514

A regular trend of increasing (in magnitude) correlations from group A to group D, indicating increasing conformity of associative structure to the theoretical model with increasing knowledge of physics, occurred for the **mLt** spatial model but not for the other spatial models. For groups A and E, however, the highest spatial model correlation occurred with the **dLv** model.

In all cases, the correlations for the hierarchical models were greater than for the spatial models for each group. The three hierarchical models were themselves substantially intercorrelated and all showed similar trends in Table 3. The between-group differences were greater for the **mLt** hierarchical model than for the other hierarchical models, however, and the largest correlation in Table 3 was between the associative structure for the sixth-form physics group and the **mLt** hierarchical model. For the other groups, however, higher correlations were obtained with the **dLv** hierarchical model.

The correlations for the graphic models followed similar trends to the hierarchical model correlations, as would be expected from the similarity of the models. But in almost all cases the correlation with the hierarchical model was somewhat greater than with the corresponding (i.e. based on same triad of concepts) graphic model.

Graphic analysis

The group half-matrices of overlap coefficients (first test only for groups A, B, and C) were analysed by a method due to Waern (1972) which yielded a graphic representation of the underlying structure—the graph depicting concepts as points, with those related connected by lines. The multi-step procedure was used in which a cut-off point is chosen and any connections between concepts noted (i.e., overlap greater than cut-off value), and then the cut-off point is successively lowered and further connections are noted. Among new connections revealed at each cut-off point, those accounted for by paths already obtained are not included in the graph. The same cut-off points (0·60, 0·55, 0·50, 0·45, etc.) were used in all the graphic analyses. An advantage of this method over such techniques as multidimensional scaling is the extra clarity afforded by the initially very simple structures out of which the final structure grows.

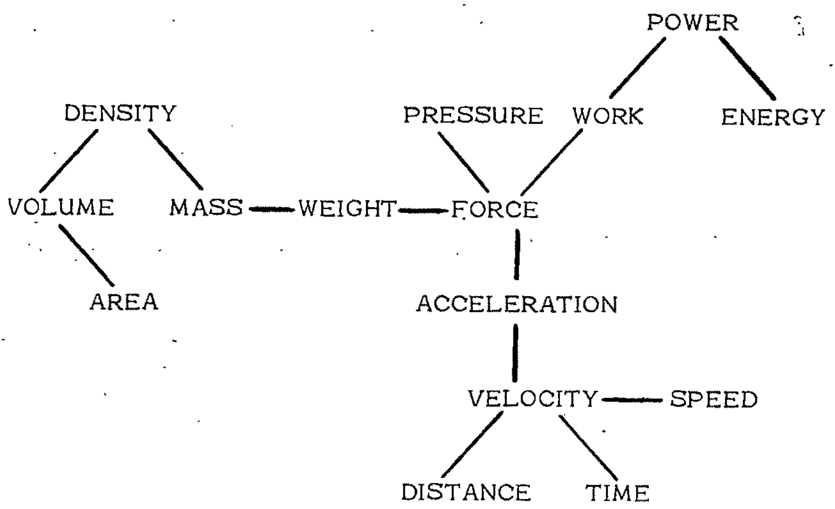
At some stage of the analysis, three clusters of concepts emerged for all the groups, although they emerged later (i.e., at lower cut-off points) and were not fully formed for groups A and E. These were a kinematics cluster containing ACCELERATION, VELOCITY, SPEED, DISTANCE, and TIME; a statics cluster containing WEIGHT, MASS, VOLUME, DENSITY, and AREA; and an energy cluster containing WORK, ENERGY, and POWER.

With a final cut-off point of 0·15, where all the analyses were terminated, only for groups C and D were all the concepts interconnected. The final structures for groups C and D were very similar, with the concept FORCE playing a central role, linking together the three concept clusters. The group C structure is shown in Figure 4, and it has been arranged so that its close similarity to the **mLt** hierarchical model of Figure 2 can clearly be seen.

The structures for groups A and E were similar to each other, with the three clusters unconnected and with a number of isolates (unconnected concepts), including DISTANCE, TIME, and WORK, for both groups, remaining at the end of the analysis. The final structure for group B contained some features of group A and some of group C. In particular, no isolates remained at the end of the analysis, but the kinematics cluster was separated from the other concepts.

FIGURE 4

THE GRAPHIC ASSOCIATIVE STRUCTURE FOR GROUP C.



DISCUSSION

Substantial stability of structure was demonstrated for the group half-matrices of overlap coefficients, and these empirical data correlated more highly with the theoretical distances derived from the hierarchical and graphic models than with the distances derived from the spatial models. The only spatial model which gave a better fit with the empirical data for the groups more knowledgeable about mechanics (C and D) than for the other groups was the one based on the concepts MASS, DISTANCE, and TIME. Moreover, for these two groups, the three **mLt** models almost always fitted the empirical data better than the alternatives based on the other triads of concepts. The closest agreement occurred between the **mLt** hierarchical model and the physics sixth-form associative structure.

For the first-form group and the non-science graduate group, the models based on the DENSITY/DISTANCE/VELOCITY (or SPEED) triad fitted the association data best. These results suggest that the special role of the concepts MASS, DISTANCE, and TIME in providing a base, or framework, for the internal organisation of mechanics concepts is acquired as a result of the way physics is taught, rather than because the concepts possess a special ostensive character. Furthermore, the lack of success of the **FLt** models did not support Winans' suggestion that FORCE, DISTANCE, and TIME formed a natural ostensive base on which the other concepts could be constructed, In fact, the concepts DENSITY, DISTANCE, and VELOCITY have a better claim to natural ostensiveness, as they seem to play a basic role in the associative structures of the two groups with the least formal knowledge of mechanics and for whom the concepts have been acquired through everyday practical and linguistic experience.

The associative structures of all the groups, as revealed by graphic analysis, were dominated by three concept groupings—the kinematics, statics, and energy clusters—although the structures were less tightly organised for the less knowledgeable groups. For the sixth-form physics and graduate science groups only, the concept FORCE occupied a central role linking together the three clusters, and for these groups the graphic structure was very similar to the **mLt** hierarchical model.

The associative structure for the non-science graduate group was closely similar to that of the first-form group, and this structure presumably reflected more than for the other groups the everyday meanings of the stimulus words. But, as noted above, the structures for all the groups were quite similar, suggesting that, on the whole, the everyday usage of these words was not inconsistent with their technical meaning. The educational significance of such structural consistency (or of inconsistencies) is, however, not fully clear. Bruner (1964), with a dialectical view of learning, has emphasised the importance of contradictions between new learning and old structures in generating cognitive development. According to Bruner, it is the attempt to eliminate the intellectual discomfort resulting from such contradictions that leads to the discovery of a new structure. This has led Bruner to support discovery methods of teaching science in which the learner encounters experimental data which cannot be assimilated within his cognitive structure. On the other hand, Ausubel (1963) has argued that it is the consistency of new material with the existing cognitive structure that renders the material meaningful. Accordingly, Ausubel has advocated an expository style of science teaching in which the first step is to present the learner with a set of organising statements which provide the 'ideational scaffolding' for subsequent learning. Gagné (1970) has also emphasised the importance in the learning process of prior knowledge and of the hierarchical organisation of concepts in which some concepts are needed for the learning of others.

The present investigation has shown that the cognitive structure of mechanics concepts for those knowledgeable in physics is quite similar to the organisation of the concepts in a learning hierarchy. This provides some evidence for the psychological (as distinct from logical) importance of conceptual hierarchies and draws together the Ausubel and Gagné approaches by suggesting that the cognitive structure which provides the scaffolding for further learning is closely related to the organisation of concepts in a learning hierarchy.

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THE STRUCTURE OF OLIVER'S 'SURVEY OF OPINIONS ABOUT EDUCATION'

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SUMMARY. Oliver's *Survey of Opinions about Education* was completed by 424 teachers in a probability sample of 50 Northern Ireland post-primary schools. Fee's binary target matrix procedure was used to transform a principal components' solution of the item correlation matrix to a factor solution congruent with the hypothesised scale dimensions of Naturalism, Radicalism and Tender-mindedness. The analysis confirmed the presence of a strong Tender-mindedness dimension, a less strong Radicalism dimension, and a weak Naturalism dimension, together with a pattern of large residual specifics. A further analysis indicated the dimensional heterogeneity of certain items, and it was suggested by way of explanation that social and educational changes since the scales were first defined may have affected the attitudinal connotation of these items, particularly on the Radicalism scale.

INTRODUCTION

OLIVER (1953) set out to discover whether it was possible to group the systematic theories of educational philosophers *and* the unformulated philosophies of practising teachers according to a meaningful taxonomy. He began by distinguishing idealism from naturalism, and went on to contrast authoritarianism with liberalism, individualism, humanitarianism and permissiveness. These two classificatory principles were seen, in combination, to designate four basic types of attitudes and educational philosophies: authoritarian idealism (Plato), liberal idealism (Froebel), authoritarian naturalism (Marx), and liberal naturalism (Rousseau).

In seeking to relate these philosophies to the categories of empirical psychology, Oliver recognised William James' distinction between the tough-minded and the tender-minded as an alternative description of the authoritarianism principle. Eysenck's (1947) two dimensions of social attitudes, radicalism-conservatism and tendermindedness-toughmindedness, were seen to resemble both principles, though Oliver suggested the need for an empirical investigation of whether his basic principle of naturalism-idealism might not be a result of Eysenck's two primary social attitudes.

Butcher (1959) has described how Oliver proceeded to construct questionnaire scales designed to sample the opinions of teachers about education on three hypothesised dimensions: naturalism (N), radicalism (R) and tender-mindedness (T). Butcher's study was designed to establish the construct validity of these scales, and the extent to which they discriminated between designated groups of teachers.

The first part of Butcher's study was subsequently reported by Oliver and Butcher (1962). The analysis was based on the opinions of a sample of teachers in the Manchester area, reduced from 440 to 300 teachers as a result of matching the sample with the population of teachers in England and Wales. Guttman scalogram analysis, applied to sub-sets of scale items for a further sample of 100 students of education, reduced the total set of 110 scorable items to 47. This analysis suggested that the T scale was the most homogeneous, and the N scale the least homogeneous of the three scales.

Thirty-two of the 47 items for the teacher sample were then submitted to a principal components' analysis, followed by Quartimax rotation. Three of the four factors thus derived were interpreted as N, R and T, respectively. The Tendermindedness scale (T) was most clearly defined, followed by Radicalism (R). The Naturalism scale (N) was less satisfactorily defined, and the authors concluded that it seemed as if the description of attitudes arrived at by psychological research fitted teachers' opinions about education better than that which is usually employed in accounts of philosophies of education.

As a result of the factor analysis the 32 items were assigned to the N, R and T scales in a shortened 59-item version of the *Survey of Opinions about Education* (Oliver, 1969). The present study was designed to test the hypothesis that teachers' opinions on this instrument, as completed by a representative sample of teachers in Northern Ireland post-primary schools, would reveal the three scale dimensions, N, R and T, reported by Oliver and Butcher.

PROCEDURE

The sample of teachers was based on 50 schools. These formed a one-in-five probability sample of all Northern Ireland post-primary schools, stratified by type (grammar and non-selective secondary), administrative designation (LEA controlled and voluntary maintained), sex (co-educational, boys only and girls only) and LEA area. The 424 teachers who completed the Oliver questionnaire represented 81 per cent of a target sample of 523 teachers. This sample, as described by Bill *et al.* (1974), included heads of schools and teachers with a minimum weekly contact of five teaching periods or the equivalent with 15-year-olds in the sample schools.

Hypothesis Testing.

Fee (1973) has described procedures which avail of a binary target matrix to transform an arbitrary factor matrix such as a principal components' solution to an hypothesised orthogonal factor structure. The procedures differ from those proposed by Horst (1965), among others, in providing for higher-order factoring where, for example, the presence of a general or group factor is hypothesised, or indicated in the first-order realm.

In order to test the hypothesis that the opinions of teachers in the designated sample would align on the three dimensions of Naturalism (N), Radicalism (R) and Tendermindedness (T) , a principal components' analysis of the 32-item correlation matrix was transformed to orthogonal simple structure by Fee's Method B. This method was designed by Fee to take account of specific factors in the residual matrix as a solution to the communality problem.

RESULTS

The results of the analysis are shown in Table 1, where the 32 items are numbered according to their sequence in the questionnaire. The table includes the binary target matrix as an aid to factor identification, together with the hypothesised three-factor solution. The diagonal matrix of specific factors is included as a column of specifics (S), since only two of the off-diagonal elements in the matrix of specifics had loadings in excess of ±0·1.

TABLE 1

HYPOTHESISED FACTOR SOLUTION.

Items	Target Matrix 1	Target Matrix 2	Target Matrix 3	Factor Matrix 1	Factor Matrix 2	Factor Matrix 3	S
1	0	1	0	−03	14	00	97
2	1	0	0	58	06	06	79
3	−1	0	0	−37	08	−09	91
4	1	0	0	22	10	04	95
5	1	0	0	20	11	07	95
6	−1	0	0	−21	−04	−13	95
7	−1	0	0	−08	−17	−22	93
8	1	0	0	01	13	06	98
9	0	−1	0	04	−27	−05	93
10	0	1	0	−05	32	05	94
11	0	1	0	−02	39	−05	91
12	0	1	0	−02	50	−09	85
13	0	1	0	04	35	−09	92
14	0	1	0	01	47	−08	87
15	0	1	0	07	35	−01	91
16	0	1	0	08	40	00	90
17	0	1	0	02	44	−06	89
18	1	1	0	−11	38	15	87
19	0	0	−1	00	00	−35	92
20	0	0	−1	01	−02	−57	81
21	0	0	−1	−09	−01	−60	78
22	0	0	−1	−04	−01	−50	85
23	−1	0	−1	−54	02	−46	69
24	−1	0	−1	−47	02	−50	71
25	0	0	−1	−03	−02	−41	90
26	0	0	−1	−09	01	−23	96
27	0	0	−1	−15	01	−31	91
28	0	0	−1	05	07	−45	89
29	0	−1	−1	−02	−17	−39	87
30	0	0	−1	04	−09	−44	88
31	0	0	−1	03	01	−55	81
32	0	0	−1	00	04	−55	82
			Percentage Variance	3·8	5·3	9·8	

(decimal points omitted)

Fee has pointed out that if the target matrix is appropriate the zero elements in the factor solution should have a distribution whose mean is not significantly different from zero and whose elements can be regarded as having been derived from the same population. When Fisher's z-transformation was applied to the factor loadings, regarded as correlations between variables and factors, and using the number of subjects in the sample, the average of the zero elements was found to be 0·0015. For a chi square of 536·8, the associated probability was approximately 1·00. It was therefore concluded that the target matrix could be regarded as having provided an acceptable solution.

In the factor solution the third hypothesised factor, Tendermindedness, is most clearly defined. The second factor, Radicalism, is also, if less strongly, identified. The first factor, Naturalism, is least satisfactory. A number of items, particularly 7 and 8, fail to identify with the Naturalism dimension, and items 4, 5 and 6 are also unsatisfactorily located. It is also evident that the obtained orthogonal solution is accompanied by a very high degree of item specificity.

Analytical Rotation.

In the course of the analysis it was observed that 11 principal components had *eigen* values in excess of unity. In view of the weak structure of the hypothesised Naturalism dimension, and an associated pattern of strong specifics, it was considered worthwhile to examine a varimax rotation of the first 11 principal components. The varimax solution is presented in Table 2.

TABLE 2

VARIMAX SOLUTION.

Items	1	2	3	4	5	6	7	8	9	10	11	h^2
1	03	−06	−10	34	−17	01	13	03	70	−13	−20	72
2	−09	04	65	06	−02	−06	−29	19	05	−18	−02	60
3	−04	20	−38	−45	17	−02	04	−08	40	−01	07	59
4	08	05	07	75	08	−04	−01	−03	19	−06	05	63
5	−12	18	24	21	−02	16	−32	−23	23	12	37	53
6	−01	20	−22	09	08	00	65	06	06	18	05	57
7	−26	05	−10	03	13	18	54	23	−08	−13	−13	52
8	−02	04	15	−03	−08	−17	−07	00	54	15	24	44
9	04	00	09	−05	13	10	15	84	−04	04	03	77
10	10	33	−28	03	−39	05	−35	19	08	−06	−04	52
11	−02	65	06	−07	−17	−07	08	−02	04	02	−09	48
12	00	64	−06	07	00	−22	00	−13	15	−01	−11	52
13	−09	67	06	08	08	−11	−05	07	−13	09	12	53
14	−03	08	−13	15	−01	−66	−10	−14	08	06	05	52
15	03	23	−17	39	02	−22	−54	06	−08	−05	11	60
16	02	14	24	−06	−01	−68	01	09	15	01	02	57
17	−01	17	−05	−04	−05	−69	−08	−07	−07	−12	−08	55
18	06	11	−04	−09	−80	−13	−08	−15	09	02	01	72
19	−10	05	−03	05	09	−06	06	−01	−07	11	−76	63
20	−46	10	00	−18	13	08	−02	−02	13	24	−49	59
21	−57	03	−19	−27	12	−01	−07	−02	18	12	−27	57
22	−46	−09	−25	13	08	−07	−08	40	16	17	−01	53
23	−35	−04	−70	−06	−02	−01	−02	05	00	17	−03	65
24	−33	00	−66	03	06	−02	−02	08	00	22	−13	62
25	−41	−19	−03	10	−10	−24	29	04	−21	34	−07	53
26	02	04	−15	−02	−02	07	−02	−01	−03	70	−11	53
27	−07	07	−19	−09	09	−01	09	06	11	73	−01	62
28	−37	07	01	33	04	−10	−01	−03	−06	35	−22	44
29	−16	04	−16	−04	76	−04	02	02	−02	08	−20	68
30	−53	−09	−01	01	01	13	−02	30	02	−04	−19	43
31	−75	16	−06	05	10	07	15	−18	−07	−06	08	68
32	−69	07	−12	−08	05	−13	08	−01	−08	−03	03	54
Percentage Variance	8·7	5·5	6·4	4·4	5·0	5·4	4·8	4·0	4·0	5·1	4·3	

(decimal points omitted)

The first varimax factor identifies the Tendermindedness scale, except for four items, 19, 26, 27 and 29. Item 19 is largely specific to factor 11. Items 26 and 27, which dominate the tenth factor, are both concerned with children's comics. It is of interest to note that these two items, together with item 25, which also loads on factor 10, were among the four items which formed a fourth uninterpreted quartimax factor in the Oliver and Butcher (1962) analysis.

The second varimax factor identifies a set of items, 10 to 13, from the Radicalism scale. Thereafter, items from this scale form the basis of the fifth, sixth, eighth and ninth factors, the last two being largely specific to items 9 and 1 respectively. Items 18 and 29, which identify the fifth factor, both refer to corporal punishment. The sixth factor relates the provision of nursery schools and play materials in primary schools to increased financial investment in education.

The third varimax factor identifies a set of items, particularly 2, 23 and 24, from the Naturalism scale, but items from this scale also load on, or identify, the fourth, fifth, seventh and ninth factors.

Internal Consistency of the Scales.

With items summed on a Likert basis, as suggested by Oliver (1969), the *alpha*-coefficients for the scales were as follows: 0·53 (N), 0·61 (R) and 0·73 (T). The obtained values show the Tendermindedness scale to be the most, and the Naturalism scale to be the least homogeneous of the three scales. The order of internal consistency for the scales is in keeping with the hypothesised factor solution (Table 1), though the values of *alpha* are considerably lower than the split-half reliabilities reported by Oliver and Butcher (1962) for the shortened scales: 0·73 (N), 0·84 (R) and 0·84 (T). This again suggests that the scales are now less homogeneous than when they were first constructed.

DISCUSSION

Two solutions to the structure of Oliver's *Survey of Opinions about Education* have been presented: the first using a target matrix to identify, *a priori*, a hypothesised scale structure; the second using an analytical procedure which permitted the structure to reflect, *ex post facto*, empirical relationships among the items.

The target method confirmed that the hypothesised structure was most satisfactory for the Tendermindedness dimension, less satisfactory for the Radicalism dimension, and least satisfactory for the Naturalism dimension. This order of structural identity was reflected in the internal consistency estimates of the scales.

The analytical procedure resulted in a more complex picture. Though the three scale dimensions, N, R and T, were discernible, each suffered a loss of items. The Tendermindedness scale was most robust, whereas the Naturalism and Radicalism scales both tended to fracture into item sub-sets. The evidence therefore again confirmed that the scales had shed something of their former structural cohesiveness.

There are three possible reasons for this: geographical, populational and temporal. The sample on which the data were based was regionally distinctive from that described by Oliver and Butcher. It was drawn from a population of teachers in post-primary schools, whereas Oliver and Butcher's sample included a population proportion of primary school teachers. The data were collected in 1972, whereas Oliver and Butcher's data belonged to the late 1950s.

McLeish (1970) has reported on international differences between teachers on the scales, and Oliver and Butcher (1968) have reported on intra-national group differences. Hussell and Smithers (1974) have reviewed a number of studies which detected scale score differences over time in the course of teacher training. None of these studies, however, has questioned the structural invariance of the scales, though the present study indicates that the Radicalism scale in particular may have undergone structural changes since it was first introduced.

For example, it may be observed how, in Table 2, items 10 and 15 were poorly dimensioned, and how items 1 and 9 were largely factor specific. Item 10 refers to the raising of the school leaving age to 16 and item 15 refers to the comprehensivisation of secondary education. Item 1 refers to reading readiness, and item 9 refers to free school meals. It is conceivable that items such as these which were indicative of radical educational opinion in the 1950s, may, through subsequent changes in school and society, have lost their radical edge in the 1970s.

The Naturalism scale provides a further possible illustration of such temporal shift. Item 4, which dominated the fourth factor in Table 2, opposes the teaching of social studies to that of history or geography. It is conceivable that this issue may now be less a matter of educational ideology than of curriculum organisation and labelling.

From the beginning doubts were expressed as to the satisfactory structure of the Naturalism scale, whereas, on present evidence, it would appear that all three scales are less homogeneous than when first defined. Since it is suggested by way of explanation that social and educational changes since the scales were first introduced may have affected the attitudinal connotation of certain items, it need therefore hardly be surprising if the most suggestive examples of this are found on the Radicalism scale.

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STRUCTURE OF THE SKILL ACQUISITION PHASE OF A MICROTEACHING PROGRAMME

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Summary. The main hypothesis tested concerns the effects of differing modes of feedback and number of ' teach ' cycles in a microteaching programme aimed at improving student teachers' use of specific teaching skills. The experimental design used a 3 × 2 × 2 factorial design with a sample of 72 students. The criteria of performance was the students' score on rating scales developed specifically for the task. Multiple regression analysis yielded no significant differences in performance in relation to type of skill practised or number of teaching cycles. However, while there was a significant increase in the mean performance, audio and video feedback had a differential effect upon low and high performances.

INTRODUCTION

Microteaching is a teacher training procedure which reduces the teaching situation to a simpler and more controlled encounter achieved by limiting the practice teaching to a specific skill and reducing teaching time and class size. The procedure involves the three phases shown in Figure 1.

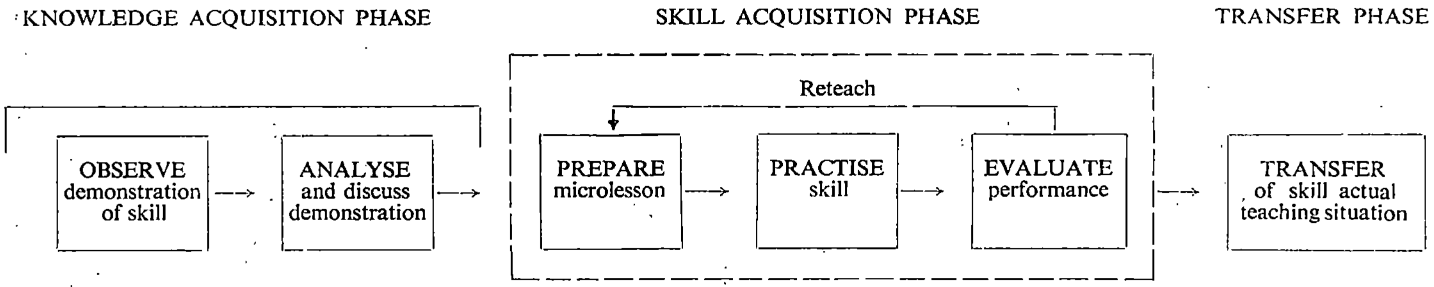
A hypothesis central to microteaching is that teaching can be described in terms of component skills (see Turney *et al.*, 1973). These skills of teaching are not necessarily discrete, but they are considered to be identifiable and, therefore, capable of independent practice. This practice of a single skill has drawn the criticism that it is too behaviouristically oriented. In particular, it is argued (Guelcher *et al.*, 1970) that it does not give the student training in identifying and selecting the most appropriate skill for the occasion. Consequently, a more dynamic approach to content design in microteaching programmes is emerging (Emmer and Millet, 1970; Gregory, 1972).

The element of feedback during the skill acquisition phase has always been seen as an essential part of the microteaching process. It is this element which has received a considerable amount of attention and has led to the controversy over the role of self-confrontation as a feedback device. The use of visual feedback dates back to Acheson's (1964) study, and since then there has been a consistent emphasis upon the value of self-confrontation using television. However, Davis and Smoot (1969) have shown the value of audio-aided feedback, while numerous authors including Doty (1970) and McIntyre (1971) have drawn attention to the desirability of the feedback being provided by a supervisor.

Despite disagreement as to the relative effectiveness of modes of feedback and the degree of specification of the skill to be learnt, the reported research does show microteaching to be an effective technique for improving students' teaching skills—Fortune *et al.*, (1967), Cooper and Stroud (1966) and Davis and Smoot (1969). The current study was based on this assumption and was concerned with analysing the microteaching technique to determine the relationship between the type of skill to be learnt, the number of practice sessions and the feedback mode which would produce the optimum learning conditions.

FIGURE 1

MICROTEACHING PHASES


KNOWLEDGE ACQUISITION PHASE
SKILL ACQUISITION PHASE
TRANSFER PHASE
OBSERVE demonstration of skill
ANALYSE and discuss demonstration
Reteach
PREPARE microlesson
PRACTISE skill
EVALUATE performance
TRANSFER of skill actual teaching situation

METHOD

Sample. For the study 72 students were randomly selected from the population of full-time students teaching either Economics or Commercial Practice or both. All students were undertaking the one-year Diploma in Education, after having graduated from their first degree course.

Microclass. For each micro-session six pupils, drawn from local secondary schools, formed the microclass. The decision to use school pupils rather than peers in the microclass was based on the finding from a number of studies that student teachers preferred to work with school pupils (Turney *et al.*, 1973).

Microteaching programme. During the knowledge acquisition phase of the programme the students attended both lecture and discussion periods during which they gained a knowledge of the skill, its elements and application. In the skill acquisition phase, the microteaching cycle consisted of a five-minute ‘ teach ’ session followed by a 10-minute feedback session. The feedback session occurred at least 50 minutes, but not more than 120 minutes, after the finish of the students’ ‘ teach ’ session. The ‘ reteach ’ elements of the cycle occurred on consecutive days.

Design. The main hypothesis to be tested concerned the effects of differing modes of feedback and number of ‘ teach ’ cycles in a microteaching programme. This gave rise to a 3×2×2 factorial design (Table 1). With a sample size of 72 students, it was possible to sample each of the 12 cells using equal cell frequencies of six students per cell. The alternative of sampling only half the cells using balanced sets would have increased the degrees of freedom but would have failed to provide any means of testing the existence of some interaction effects. As prior knowledge on interaction effects was not substantial, it was decided to use all observations on each combination of skills, method of feedback and number of cycles.

TABLE 1

EXPERIMENTAL DESIGN.

	b1			b2		
	c1	c2	c3	c1	c2	c3
a1	abc111	abc112	abc113	abc121	abc122	abc123
a2	abc211	abc212	abc213	abc221	abc222	abc223

Where a=the number of cycles per skill.
b=the skill to be learnt.
c=method of feedback.

Number of cycles per skill. The available research literature provides no conclusive evidence as to the number of cycles a student must undergo in order to gain competence in a set skill. The choice of four cycles (a1) was made on the basis that this number of cycles appeared to be the most common in use for the practice of one set task. A six-cycle programme (a2) was then chosen to test if an extra two cycles, i.e., 50 per cent increase of practice, would result in either some significant gain or loss in performance.

Feedback mode. In the light of the evidence from the literature (Clift *et al.*, 1974), the feedback modes for the design were: feedback from a supervisor (c3); feedback from a supervisor aided by audiotape replay (c2); feedback from a supervisor aided by audio/video tape replay (c1). The supervisors were drawn from the methods staff and received special instructions in the use of audio or video replay as an aid in the feedback session.

Skill to be practised. The task for the current study reflected the more dynamic approach suggested by Gregory (1972) rather than the original technical skills concept. Already identified skills appearing in the literature were analysed and then reclassified within a hierarchical scheme as either duties, tasks, skills or elements of skills. This analysis did not succeed in providing a classification with complete and sharp distinctions between activities, but did provide a logical framework upon which to develop the microteaching programme content. The set task for this study was that of set induction. Within this frame of reference the students were required to focus upon improving either their skills of questioning or demonstrating. This approach allowed the demonstrator to ask questions and the questioner to use non-verbal cues where appropriate, although emphasis during the microlesson was to be given to practising the designated skill.

Criterion of attainment. The criterion used to test the students' performance was a summed score for each student on a battery of independently rated items on three sub-scales: verbal-specific, voice and speech, and non-verbal. These sub-scales were developed for the study by factor analysing a number of elements considered to reflect skill in the use of questioning or demonstrating (Clift *et al.*, 1974). The raters were members of the research staff of the Higher Education Research Unit. Each rater was assigned to a specific sub-scale of the overall rating scale, and practice rating sessions were held. Pre-recorded first and final microteaching sessions were selected at random and edited on to a rating tape. Each session on this tape was then assessed by the rater. In a mark-remark situation over a six-month period where the three raters scored the same microteaching session, the Pearson product-moment correlation gave the results shown in Table 2.

TABLE 2

CORRELATION COEFFICIENTS FOR RATER CONSISTENCY.

Scale	Pearson Product-Moment Correlation	
	First Session	Final Session
Verbal Specific	·71	·87
Non-verbal	·89	·79
Voice and Speech	·74	·78

A test-retest reliability measure gave a reliability figure of ·59 for the overall rating scale. However, given that each performance of a subject would possibly be different, the use of a test-retest reliability measure could not be considered as being an accurate indication of item reliability. Furthermore, as only the first and last microteaching lessons were rated, this test-retest reliability figure of ·59 could be an underestimate of the stability of the ratings.

Given an overall reliability figure of ·59 and that the amount of variance attributable to the rotated items in the factor model is ·402 for the first session and ·462 for the final session, then by the use of a completeness of factorization formulae (Harman, 1970, p. 19) it can be established that the percentage of the reliability variance that is accounted for by common factors within the rating battery is 68 per cent and 78 per cent, respectively.

Form of the data analysis. The main data analysis was carried out using multiple regression techniques. Such techniques were considered to have greater flexibility and power than analysis of covariance (Cohen, 1968). It can provide estimates for the size of particular effects as well as their contribution to explained variance of the criterion variable.

RESULTS

There was a large and highly significant increase in average performance from 79·09 on the first ' teach ' session to 96·19 on the final session. However, such improvement in performance simply confirmed the effectiveness of the microteaching techniques, whereas the purpose of the research was to identify the optimum format.

The values for each of the cells of the factorial design are given in Table 3. The adjusted scores were found by regressing the criterion variable (score on first ' teach ' session) and subtracting the resulting expected value of the criterion from its actual value. The adjusted cell mean was then subtracted from the grand mean (96·19) to give the deviation score.

TABLE 3

DEVIATION OF ADJUSTED CELL MEAN FROM GRAND MEAN FACTORIAL DESIGN.

	Questioning			Demonstrating		
	Video	Audio	Supervision	Video	Audio	Supervision
4 Cycles						
Deviation	−1·717	3·889	6·649	−2·892	−3·746	−6·090
Standard error	2·22	2·11	3·27	2·35	3·57	3·02
(N)	(6)	(6)	(6)	(6)	(5)	(5)
6 Cycles ..						
Deviation	−2·863	6·853	1·457	4·643	3·620	−2·304
Standard error	2·67	4·55	4·95	3·69	5·82	2·94
(N)	(6)	(5)	(6)	(6)	(5)	(5)

The deviation score for six cycles (Table 4) was positive and that for four cycles negative, but the deviation score for video was negative, while those for audio and supervisor were positive with audio higher than supervisor. However, in no case was the deviation score significant on a two-tailed ' t '-test.

Analysis with the regression model including only the experimental variables and their interactions explained only ·24 of the variance in the criterion variable, and the F ratio for the whole model was not significant. Students' characteristics as measured by score on the first ' teach ' session was associated (P< ·01) with student performance. Inclusion of this variable with the experimental variables and their interaction boosted the proportion of variance explained to ·37, but student score on first ' teach ' session alone accounted for ·18.

TABLE 4

DEVIATION OF ADJUSTED CELL MEAN FROM GRAND MEAN EXPERIMENTAL VARIABLES.

	Feedback		
	Video	Audio	Supervisor
Deviation	−0·707	0·490	0·303
Standard error	1·45	2·14	2·03
(N)	(24)	(21)	(22)
	Cycles		
	Four Cycles	Six Cycles.	
Deviation	—1·773	1·827	
Standard error	1·26	1·67	
(N)	(34)	(33)	
	Skill		
	Questioning	Demonstrating	
Deviation	·917	−1·003	
Standard error	1·48	1·54	
(N)	(35)	(32)	

Analysis of the reduction to explained variance by the exclusion of the experimental variables showed that only the mode of feedback had a noticeable effect, and even that was not significant on an F-test.

Inclusion of the variables representing the interaction of the experimental variables with student score on the first ' teach ' session, did yield one variable —the interaction with audio feedback, which added significantly to explained variances in a number of models. In the full model, (R^2= ·43), excluding the interaction with audio feedback, it fell by nearly ·05 to ·38, and the F ratio was close to the 5 per cent level. Further estimates with models including the interactions between the experimental variables showed the interaction between audio and student score on first ' teach ' session added significantly to the proportion of variance explained. Individual partial regression coefficients for these latter two variables showed that audio feedback had a positive effect on the performance of students who rated low scores on the first teach session, and a negative effect for those students who scored high on the first teach session. Both effects were significant at the 5 per cent level on t-tests. In contrast, the interaction for supervision feedback and video-aided feedback with student score on first ' teach ' session was not significant.

DISCUSSION

While overall there appears to be no preferred method of feedback, there was evidence of a variation in individual student response to feedback mode and to the technique of microteaching. Each experimental group showed a significant mean improvement between first and last sessions, but a few students who were spread across the groups showed no improvement, and there were some whose performance was rated as actually deteriorating over the total programme. Such a finding is consistent with that of Chavers *et al.* (1970), who found that microteaching produced a differential effect on students' learning. This could be due to an aptitude-treatment interaction with the microteaching technique itself or it could be student reaction to the technical skills approach. If the student possessed a natural teaching style not in accord with the designated teaching skill, then his reaction to the set task may well inhibit a satisfactory performance.

Microteaching practitioners continually maintain that video replay is an integral part of the microteaching technique, yet the results of this study are in keeping with the findings of Scheuller *et al.* (1962), who found that the addition of video recordings to the supervisor conference did not significantly improve student teaching, and Hiscox and van Mondfrans (1972) who found no significant difference in the effectiveness of audio and audio-visual tapes as forms of feedback to improve either verbal or psychomotor skills. This conflict between expectations and the research finding on the value of video-playback is reviewed fully by Fuller and Manning (1973). They concluded that some kinds of students would benefit more from self-confrontation than others.

In studying the use of television as an educational aid, Vernon (1953) concluded that the particular appeal of television does not automatically produce accurate impressions and, hence, there is a need to provide "logical coherent verbal statements" to "tie" the visual material together. Without such guidance and structure the student's own emotional response will tend to distort his perception and retention of the visual material. In their review, Fuller and Manning reach a similar conclusion and suggest that the self-viewers' attention requires to be focused on the task to be observed, otherwise their attention will tend to concentrate on their own self-image. This conclusion is supported by Alper *et al.* (1972) who found that the analysis of a model of the desired performance was necessary to promote the initial change in behaviour, and that this change was then accelerated towards the required standard by self-confrontation. A limitation to the current study was the relative lack of attention given to the acquisition phase of the programme, and it may be that this had a greater influence on the effectiveness of the video-assisted feedback than on either of the other two modes.

Fuller and Manning (1973), in summing up the debate on audio *versus* video feedback, feel that both may have a role to play, but that for tasks which are predominantly verbal, such as questioning, audio is less stressful and, hence, may be more useful. However, the studies reviewed provide no explanation of the present findings that audio-assisted feedback appears to be advantageous to students whose initial performance was rated as below average.

The existing evidence from the literature and the findings from the current study provide a strong case for a selective approach in the application of both the technical skills approach and self-confrontation when using the microteaching technique in the preparation of student teachers.

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SYMBOLISM AND INTELLECTUAL REALISM IN CHILDREN'S DRAWINGS

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SUMMARY. Various distinctions which have been applied to the development of children's drawings are considered critically, and a distinction between symbolism and intellectual realism is suggested. Drawings made by 42 5- to 7-year-old children of familiar objects with distinctive characteristics were examined. Results provided support for the suggested symbolic or generic character of much children's drawing.

INTRODUCTION

THE term ' symbolism ' was introduced in relation to children's drawings by Burt (1921). He identified a stage of ' descriptive symbolism ' during which the child represents things by crude symbolic schemes which remain fairly constant for particular children over long periods of time. The symbolic representation refers, not to the present individual object, but to the generic type.

Luquet (1913, 1927) introduced the phrase ' intellectual realism,' and this has since been integrated into Piagetian terminology (e.g., Piaget and Inhelder, 1969). Intellectual realism precedes visual realism and is characterised by the child drawing ' what he knows and not what he sees.' There is an ambiguity, however, in the notion of intellectual realism. Is the child drawing what he ' knows ' about the individual object, or about its generic type? It seems clear from Burt's work and from more recent studies (e.g., Freeman, 1972) that early representation is stereotypic in character, and equally clear that visual realism requires attention to the individual object. Hence, we should expect two distinct developmental adjustments. Firstly, the child has to move from depicting the genus to which the object belongs to depicting what he knows of the present individual object. Secondly, he has to move from representing this knowledge of the individual object to representing his visual perspective upon it. There seems no reason to suppose that these two steps should be developmentally synchronous. Consequently, we should expect to find *three* distinct stages, for which we shall use the terms symbolism (S) in which the child draws what he knows about the genus, intellectual realism (IR) in which he draws what he knows about the individual, and visual realism (VR) in which he draws the individual object as he sees it. The present study is an attempt to identify these stages empirically and thus to substantiate the distinctions made above.

METHOD

Sample.

Children from three classes of a Cambridge infant school participated in the study. The age ranges in the three classes were non-overlapping: 5 yrs. 2 m.—5 yrs. 5 m., 5 yrs. 6 m.—6 yrs. 0 m., and 6 yrs. 6 m.—7 yrs. 0 m. Each was treated as a separate age group and designated I, II and III, respectively.

All of the children in the three classes were asked to provide initial free drawings, but for individual testing 14 children were selected at random from each age group.

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Procedure.

The initial free drawings of houses were examined for inclusion of a door and curtains, and the sizes of the upstairs windows were compared with those downstairs; the drawings of cups and saucers were examined for inclusion of a handle and any decorative features. The significance of these points will become apparent. Each of the children selected from the three classes was tested outside the classroom. A model of a house was placed on a table so that the front and one side were visible to the child. Freeman and Janikoun (1972) have shown the advantage of using a commonplace model incorporating distinctive features. In the present case the model house had three notable features; there was no door, the upper windows were larger than the lower, and there were curtains in the windows. The children were asked to draw the house, and then their drawing was removed and a story was told to them about the house. The story (which concerned Mr. Popoff, the inhabitant of the house, and his magical habits) was such as to give significance to the house not having a door and to the upper windows being larger than the lower. No mention was made of the curtains. After the story the child was asked to draw the house again. The drawing was then removed, and the model house put away.

A second test was then given to the same child, this time with a cup and saucer as model. The procedure was just as for the first test: the model included distinctive features (it had no handle and was decorated with gold lines and flowers) and a story was told, continuing logically from the first story, which drew attention to the absence of a handle and to the gold lines, but not to the flowers. Again, drawings of the model were obtained before and after the story.

Rationale.

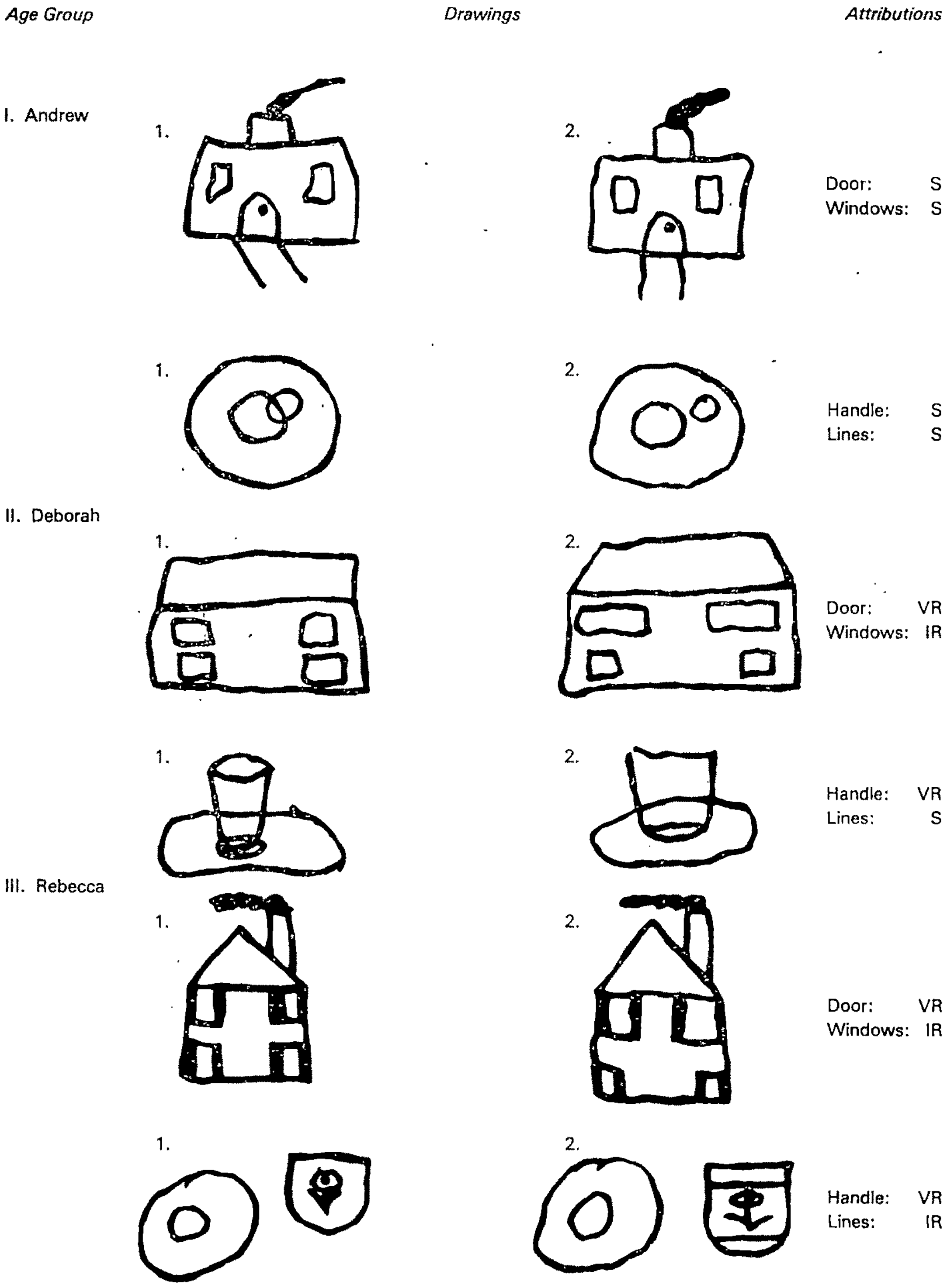
The rationale behind this procedure was as follows: It was assumed that these children's prior knowledge about houses included the fact that houses have doors, and indeed, all the free drawings obtained from the three classes contained a door. Thus, if a door appeared in the child's first drawing of the model house, this could be attributed either to intellectual realism or to symbolism. The drawings obtained after the story had been told could then be used to distinguish between these two groups. An intellectual realist would have incorporated a door into his first drawing of the model house because he know that houses must have doors and, after all, he can only see two sides of this house. But, after the story the intellectual realist knows that *this* house does not have a door—this being the logical hinge of the story—so he would omit the door in his second drawing. The symbolist, on the other hand, would not significantly alter his 'house-symbol' from the first drawing to the second, and would ignore information given concerning the specific house that he has been asked to draw. He would thus include a door in both drawings. The visual realist, of course, would not include a door in either drawing.

Similar considerations apply to the relative sizes of upper and lower windows. In the free drawings obtained before the sessions, no children differentiated between window size on the two levels, although a few included windows on one level only. The differential window size in the model, although essential to the sense of the story, was a rather more subtle point than the absence of a door and was expected to be rather harder for the children to pick up. Apart from these considerations relating to the door and windows, drawings were scored for inclusion of curtains (which were present in the model but not marked in the story) and for the inclusion of adventitious detail (e.g., chimney, TV aerial, garden) not present in the model.

The rationale of the second test with the cup and saucer as model was identical to that of the first, the reason for including this second version of the test being to see how far allocation of a child to one of the three categories was independent of the particular model used.

FIGURE 1

Sample of Drawings Obtained Illustrating the Method of Scoring.
S=symbolism, IR=intellectual realism, VR=visual realism.)



RESULTS

For each child the two house drawings were compared in respect of door and window details and the two cup and saucer drawings were compared in respect of handle and line decoration details. Thus, four separate attributions of visual realism, intellectual realism or symbolism could be made for each subject. Figure 1 gives examples of such attributions. All four may be the same, as in the case of Andrew, but in many cases attributions differ for different characteristics. For example, Rebecca (Figure 1) omitted the door in both house drawings, but only enlarged the upper windows in the second drawing, and showed a similar pattern with the cup and saucer drawings. The features used as indices were sufficiently clear cut for there to be complete agreement between the two authors' independent categorisations. Numbers were rather small for examining subjects' consistency between house and cup drawings. However, VR attributions based on the *door* feature in the house drawings were systematically related to the VR attributions based on the *handle* feature in the cup drawings ($\chi^2=7\cdot0$, df$=1$, $P<\cdot01$). Similarly, S attributions in the two cases were significantly interrelated ($\chi^2=15\cdot9$, df$=1$, $P<0\cdot001$). For IR attributions the same seemed to be true, but numbers were too small for statistical analysis. All the free drawings of cups collected before testing had handles, just as all the free drawings of houses had doors. The door feature stood in the same relationship to the house story as the handle feature to the cup story. The degree of consistency in the results for these two features indicates that we are dealing with something which is not entirely situation-specific, while the differences between the results for these and for the windows in the house and lines on the cup indicate that one cannot expect to pin the child down to a stage of development independent of the level of difficulty of the particular problem used.

Table 1 shows the age changes in frequency of the various attributions. Between the younger and the oldest groups there is a decrease in the frequency of S attributions and an increase in both VR and IR attributions. The change in distribution of attributions across this age range is statistically significant ($\chi^2=10\cdot0$, df$=2$, $P<0\cdot01$).

TABLE 1

TOTAL NUMBERS OF ATTRIBUTIONS TO EACH CATEGORY FOR EACH AGE GROUP.

		Age	
Type of Drawing	5½—	5½—6	6½+
Symbolic	44	35	28
Intellectual Realism	6	8	15
Visual Realism	6	13	13

Amongst all the subjects there was not a single case in which the child's first drawing of the model was more realistic than the second in respect of any of the particular characteristics examined. Thus, all sets of drawings could be satisfactorily accounted for in terms of the symbolism, intellectual realism and visual realism categories.

The inclusion of ' irrelevant ' detail actually present in the models (e.g., curtains in the house, flowers on the cup) increased significantly with age, as one might have expected. Detail not present in the model (e.g., smoke, garden paths, etc.) tended also to increase with age, though not significantly.

DISCUSSION

Our results support the distinctions drawn in the introduction, and in particular suggest the existence of a distinct ' symbolic ' form. This in turn requires that the term ' intellectual realism ' be used in a more restricted sense than is usual.

This finding is not without significance. For Piaget and Inhelder (1969), in uncritically adopting Luquet's classificatory system, assume that all children's art is necessarily realistic in intent. They thus consider children's drawings to be a form of imitation of an object (imitative accommodation) with all concessions being made by the child, there being " no question of a free assimilation of reality to the subject's own schemes " (p. 63). Yet we have seen in the ' symbolic ' phase a disposition to represent the object generically rather than as an individual. Information which the child possesses relating to the particular object (imparted to him in the present study by means of a story) may be entirely ignored in the execution of a drawing. At this stage, then, the child, far from accommodating directly to reality, seems to be assimilating reality to his own schemes. Consequently, Luquet's use of the term ' intellectual realism ' to cover this phase of development can only be viewed as misleading. It was this consideration which in fact led us to suggest in the introduction to this paper that ' symbolism ' is a term more apt to denote this earlier phase of development, intellectual realism proper forming an intermediate phase bridging symbolism and visual realism.

Clarification of this problem obviously requires much more research; it is the hope that this paper may serve as a stimulus to further studies upon symbolism in children's drawings, studies which may ascertain the nature of the symbols employed and the processes involved in their ontogenesis.

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QUESTIONS CHILDREN ASK ABOUT SPATIAL ARRAYS: AN ANALYSIS OF THE PROCESSES INVOLVED IN CO-ORDINATING PERSPECTIVES

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SUMMARY. Strategies used to co-ordinate perspectives were investigated using a modification of Mosher and Hornby's ' twenty questions ' technique. By asking ' yes/no ' questions, children (N=75) attempted to predict the viewpoint of another, in order to match it to their own perspective of a duplicate array. In coding these questions, it was found that most children asked about the *orientation* of objects, rather than their *positions*. Although those asking position questions performed better than those asking orientation at grade 3, there was no relation between strategy and success at grade 7. The results are discussed in relation to inconsistencies in the literature regarding age differences in the co-ordination of perspectives.

INTRODUCTION

PIAGET and Inhelder (1956) have suggested that young children are not aware of the relativity of visual perspectives. They tend to assume that their own perspective will be shared by others, regardless of any differences in observer-array relations. This behaviour has been investigated using the ' co-ordination of perspectives ' task, in which children are shown a model of three mountains, and asked to select one picture from an array, to depict the specific viewpoint enjoyed by a doll at various positions round the model. If the child incorrectly chooses the picture corresponding to his own viewpoint instead of the doll's, this is taken as evidence of *egocentrism*, or failure to recognise the possibility of alternative perspectives. Piaget described the child's development from this egocentric outlook, through a number of stages, to one in which he not only recognises that alternative perspectives exist, but is also able to construct such perspectives.

Various studies have shown that the child's level of egocentric responding is not absolute, but influenced by the kind of information available to him when making a response. For example, the likelihood of an egocentric response is a function of the response mode employed (Fishbein *et al.* 1972), and of whether the child selects his own view before or after that of the doll (Aebli, 1967; Garner and Plant, 1972). It is also dependent on the number of stimuli in the display (Brodzinsky *et al.*, 1972; Fishbein *et al.*, 1972) and whether the child is able to view the display from more than one perspective before attempting the task (Eiser, 1974). Research in this tradition, therefore, has attempted to study the processes involved in co-ordinating perspectives primarily by identifying factors which influence the probability of an egocentric response.

The focus of the present study is to investigate the manner in which egocentric and non-egocentric responses are derived, particularly with identifying the processes which may underlie the co-ordination of perspectives, rather than with the overt level of egocentric responding. Instead of manipulating the kind of information given to children, and attempting to infer the use that is made of it, our purpose is to investigate the kind of information which they themselves seek in order to solve the task.

Other attempts to investigate these processes have led to the conclusion that the child's difficulty is not so much in predicting that another's viewpoint may differ, but rather in uniting the imagined perspective with the observer's position (Huttenlocher and Presson, 1973). According to Coie *et al.* (1973), the child's increasing success with age may be traced through several discrete steps, but these need not necessarily be phrased in terms of the declining influence of egocentrism. Rather, they describe the developmental sequence as involving emphasis, at younger age-levels, on *what* is seen. This later shifts to an emphasis on *how* objects are seen, and finally subjects attempt to take cognisance of *where* objects are seen.

Despite their change in emphasis, neither of these studies in fact allows us to make inferences as to how the child exactly sets about solving the task. To answer this question, we need to adopt a method in which the strategies subjects may normally use covertly, can be made overt. A task was, therefore developed, based on the 'twenty questions' technique, used by Mosher and Hornsby (1966). In applying this to the co-ordination of perspectives task, we used a multiple object array, and asked children to predict the experimenter's perspective, by asking a series of questions which required ' yes ' or 'no' answers, about a particular viewpoint. Thus, child and experimenter each have identical visual displays, the experimenter rotates hers to give a new perspective, and the child then attempts to infer this perspective in order to match his own to it. The child's age and success on the task may then be related to the kind of questions which he asks.

In considering which questions children might ask, there appear to be two broad categories available, corresponding to the two aspects of space (orientation and position), described by Pufall and Shaw (1973). Thus, the alternative perspective may be anticipated by focusing on changes in the *orientation* of objects as a function of the observer's position. In this case, we would expect questions concerned with whether the back, front or side of an object, were in view. We might also expect questions concerned with specific features of objects; in the case of animals in the display, for example, children might ask whether the eyes were visible. The alternative strategy is to focus on changes in the *positions* of objects; which is placed at the back or side of the display, for instance? In selecting a rotation task, we made these strategies interdependent, in that as the stimuli were fixed in position, questions about the orientation necessarily yielded information about the position, and *vice versa*. The adoption of either strategy should enable the child to reach a correct solution. However, the work of Coie *et al.* (1973), would lead us to predict an increase in the use of position, over orientation, questions with age, as this would be in line with the finding that children progress from a focus on *how* objects are seen, to one of *where*.

METHOD

Sample.

The sample consisted of 75 children in all. There were 13 girls and 12 boys in grade 3 (mean age=8·4 years, s.d.=0·33), 11 girls and 10 boys in grade 5 (mean age=10·3 years, s.d.=0·45), and 19 girls and 10 boys in grade 7 (mean age=12·2 years, s.d.=0·52). All the children were white, and attended a large Catholic school in a lower middle class district of Kitchener, Ontario. Testing was carried out by the author, in a mobile trailer parked in the school grounds, and was completed in one 30-minute session for each child. It was necessary to obtain parental consent before children could participate; approximately two-fifths of parents did not give this consent.

Stimuli.

Children's ability to co-ordinate perspectives was investigated using two tasks. A *pre-task* consisted of the stimuli described by Flavell *et al.* (1968, pp. 55-70). Four sets of stimuli were used: (*a*) a large triangular block, (*b*) three cylinders of equal height and colour, (*c*) three cylinders of differing heights, but the same colour, and (*d*) three cylinders, differing in both height and colour.

For the *experimental* task, two identical sets of stimuli were used; one by the child, and one by the experimenter. Each set consisted of three brightly painted, plaster-of-Paris models of a mushroom, a mouse, and a snail. These were 17 cms., 13 cms., and 5 cms. high, respectively, and were glued in position on a green circular board, 30 cms. in diameter. From an initial position, the mushroom was on the child's left, the mouse to his right and facing him, and the snail in the foreground facing toward the mouse. There was a patch of ' grass ' at the base of the mushroom and a similar patch at the feet of the mouse. Each set of stimuli was mounted on a ' lazy Susan ' tray, which could be rotated on top of a slightly elevated base. This base was marked in degrees to enable the experimenter to read off the difference between the child's final placement of the tray, and the correct view. Subject and experimenter were seated side by side, separated by a screen, and both looked down on the stimuli from an angle of approximately 30°.

Procedure.

In the pre-task, the child was asked to predict the viewpoint of the experimenter in two different positions for each set of stimuli. These were the positions opposite the child, and then that to his side. The child was to place identical stimuli so as to replicate the experimenter's view. As Flavell (1968) and his colleagues argued that the stimuli formed an ordered series in terms of difficulty, testing was stopped when the child failed to predict the required perspective on both trials (i.e., opposite and to the side), of a given set of stimuli. This procedure was also adopted in the present situation.

In the experimental task, the child was shown both sets of stimuli, and it was emphasised that these were identical. The child was then asked to name and describe each object. His tray was then rotated through 180° and again the child asked to describe the stimuli. If he appeared not to understand at this point, or replied that the stimuli looked exactly the same as before, the tray was turned to other positions and the procedure repeated. After a maximum of three trials, each child gave different descriptions of the stimuli as a function of their perspective, suggesting that he was focusing on some aspects which were relevant to the task. Subjects were then given the following instructions: " What I am going to do now is to turn my tray round, so that my objects look different from how you see yours. Now what you have to do now is to try and guess how the objects look to me. The way you do it is like this. You can ask me as many questions as you like, but you must ask them so that I can just say ' yes ' or ' no.' Can you think of a question that has just got a ' yes ' or ' no ' answer? . . . You can turn the tray round while you are asking the questions. When you think you know how the objects look to me, then make yours look the same: so that we can both see the same, and tell me to come over and see."

Where the child had difficulty formulating a question, he was asked to describe how the objects looked to him again. If he said, for example, " I can see the front of the mouse," the experimenter replied, " Well, if you asked me if I could see the front of the mouse, and I said ' yes,' then you would know that my tray was turned so that I could see the front of the mouse too. If I said 'no,' you would know that my tray was turned around. What would you have to ask me then?" So that children were not 'cued' in to either strategy, the experimenter always used the child's own description of the model to create appropriate questions. Thus, if the child said, "I can see the mouse is at the front," the experimenter suggested the child ask a question of the type, "Is the mouse at the front?" It was felt that this procedure minimised the possibility that the experimenter might 'cue' the child to ask questions of a particular type. All the children were subsequently able to produce other relevant questions.

After the instructions, the experimenter went behind the screen and rotated her tray. Each child attempted four trials in the same order; at positions 270°, 90°, 315° and 135° in a clockwise direction from his initial view. After each trial, the child's placement of the tray was noted, and it was then rotated back to the initial position. The child's questions were recorded throughout the session.

RESULTS

Quantitative treatment.

The pre-task was scored as described by Flavell *et al.* (1968). These scores ranged from the completely egocentric (score=0), to non-egocentric (score=36). As Flavell found, younger children scored more egocentrically. The mean scores for grades 3, 5 and 7 were 9·92, 22.91, and 22·59, respectively; a one-way analysis of variance on these scores was significant ($F(2,72)=13{\cdot}03$, $P<{\cdot}001$).

In the experimental task, the degree of error for each child was calculated by noticing the difference in degrees between the child's placement of the tray and the correct position. In all cases, the smallest error (to the nearest 5°), was taken. Thus, if the correct position was 270°, then a placement of 0° or 180° was recorded as a 90° error. Similarly, a placement of 315° or 225° was recorded as a 45° error. A mean error score over the four trials was then calculated for each child. The mean error score was less for older children (mean error for grade 3=70·88°, for grade 5=46·68°, and for grade 7=41·38°; $F(2,72)=9{\cdot}04$, $P<{\cdot}001$). There was also a slight, but not significant trend, for older children to ask fewer questions (mean number of questions asked by grade 3 children=7·90, grade 5=7·28, and grade 7=6·00; $F(2,72)=1{\cdot}84$). There was no relation between error scores and the number of questions children asked; the correlation between these being 0·23 at grade 3, —0·01 at grade 5, and —0·12 at grade 7.

Qualitative treatment.

Subjects' questions were coded independently by two judges, using the following schema. A fundamental distinction between *orientation* and *position* questions was adopted. Within the *orientation* category, the following subcategories were adopted:

(1) Whole-part. These questions were simply concerned with whether an object was completely in view, or not. e.g., "Can you see all the snail?"

(2) Side. Here questions referred to a side of an object, without specifying which side, e.g., "Can you see the side of the mouse?"

(3) Facing. These questions focused on the direction of the object itself, e.g., "Is the mouse facing you?" Also included in this category were questions of the type, "Can you see the mouse's face?"

(4) Back-front. Only questions specifying the front or back were included, e.g., "Can you see the front of the mouse?"

(5) Left-right. Again, only if questions specified the left or right sides were they included, e.g., " Can you see the mouse's left side? "

(6) Features. These questions focused on distinctive aspects of the objects, e.g., " Can you see the mouse's eyes? " " Can you see the stem of the mushroom? "

(7) External reference. In this category, we included questions about the direction of an object in relation to a reference outside of the experimental stimuli, e.g., " Is the mouse near the door? "

Within the position category, we were able to distinguish a number of specific question types, e.g., *Back-front*, " Is the mushroom at the back?", *Left-right*, " Is the mushroom on the left? "; and *Other*, " Is the mushroom in the middle/to the North? " However, these questions did not occur with sufficient frequency that any analyses could be conducted. Finally, we identified a category of *irrelevant* questions, which included those which would not enable the child to reach a solution to the task, e.g., " Does the mouse look hungry to you? ", " Is the mushroom red and yellow ? " These questions were concerned with aspects of the stimuli which were constant regardless of the observer's position.

Using this schema, interjudge agreement was high (approximately 95 per cent). Where there was disagreement, judges attempted to resolve the problem by discussion; if they were unable to reach a solution, the question was placed in a *miscellaneous* category.

Statistical analysis.

Our main concern was twofold; firstly, with the differences between grades in the use of particular strategies, and secondly, with assessing the informational value of these strategies to children at each grade. In view of the wide differences within each grade in the number of questions asked, it did not seem sufficient to assess this informational value by simply looking at the degree of error in the child's final response. Since one child could achieve the same error score as a second, by asking, for example, half as many questions, it seemed that a measure of how efficiently subjects performed the task needed to take into account both their final error and the number of questions they asked. An ' efficiency ' score was, therefore, calculated by multiplying each child's mean error score by the mean number of questions asked. Within each grade, subjects whose scores were above the median, *for their grade*, were classified as efficient, and those whose scores were below the median, as inefficient. Subjects at the median were randomly assigned to efficient or inefficient categories. As would be expected from the grade differences in error scores and the number of questions asked, these efficiency scores decreased with grade; (median efficiency score for grade 3=360·0; for grade 5=250·0, and for grade 7=200·0). Subjects' strategies were then compared using a 3 (grade) by 2 (efficiency) design.

An orientation strategy was adopted significantly more often by inefficient than efficient subjects ($F(1,69)=13{\cdot}03$, $P<{\cdot}001$). Neither the main effect for grade ($F(2,69)=2{\cdot}28$), nor the grade by efficiency interaction ($F(2,69)=3{\cdot}13$, $P<{\cdot}1$), were significant. The mean scores, shown in Table 1, suggests that the efficiency main effect may be largely attributable to differences in the use of the orientation strategy between efficient and inefficient subjects at grade 3; this being considerably reduced for older subjects. The unequal group sizes complicate the assumptions underlying the partialling of this interaction into its linear and quadratic components. However, to assist interpretation of the interaction, a separate 2 by 2 analysis of variance was conducted on the percentages of orientation questions asked by grade 3 and grade 7 subjects only. The main effects for grade ($F(1,50)=4{\cdot}37$, $P<{\cdot}05$), and efficiency ($F(1,50)=9{\cdot}76$, $P<{\cdot}01$) were significant, as was their interaction ($F(1,50)=6{\cdot}70$, $P<{\cdot}05$), suggesting that there is a trend for the relation between the orientation strategy and efficiency to decrease with age. As we would expect, the use of the position strategy complements that of orientation. Although there was no main effect for grade($F(1,69)=0{\cdot}40$), efficient subjects were more likely to use the position strategy ($F(1,69)=0{\cdot}01$, $P<{\cdot}005$) than inefficient subjects were. The incidence of *irrevelant* and *miscellaneous* questions was too low to enable statistical tests to be conducted.

TABLE 1

MEAN PERCENTAGES OF QUESTIONS ASKED IN EACH CATEGORY AS A FUNCTION OF GRADE AND EFFICIENCY.

	Grade					
	3		5		7	
Orientation	effic.	ineffic.	effic.	ineffic.	effic.	ineffic.
Whole-part	4·56	9·02	6·86	16·70	6·67	8·72
Side	5·26	6·22	10·89	10·28	8·20	15·91
Facing	2·49	10·77	7·51	4·86	8·85	4·20
Back-front	8·45	10·73	17·42	12·32	18·31	28·77
Left-right	1·85	0·25	0·88	9·63	5·52	3·41
Features	9·79	39·08	10·47	26·59	17·11	15·81
External reference	0·83	6·09	5·91	4·31	9·36	1·04
Total orientation	33·48	82·16	59·95	84·69	74·02	77·86
Total position	41·25	8·02	35·26	13·30	22·01	12·74
Irrelevant	15·74	6·95	0·00	0·00	3·38	3·26
Miscellaneous	9·53	2·87	4·79	2·01	0·59	6·20

Among the sub-categories of orientation questions, we found that the use of front-back questions increased with grade ($F(2,69)=4{\cdot}80$, $P<{\cdot}025$), while efficient and inefficient children differed largely in terms of their use of features questions. Inefficient children used this strategy more than efficient ($F(1,69)=6{\cdot}40$, $P<{\cdot}025$), but as seen in Table 1, this effect was again mostly due to grade 3 children; the use of features questions not being associated with efficiency for older children.

Subsidiary analyses.

(1) *Relation with the pre-task.*

With the effect of grade removed, there was a significant partial correlation between children's mean error scores and their scores on the pre-task($r=-0{\cdot}36$, $df=73$, $P<{\cdot}001$). This suggests that similar cognitive processes are involved in the experimental task as in other tasks of co-ordination of perspectives.

(2) *Adoption of alternative strategies.*

The number of children using both an orientation and position strategy, rather than one or the other, is shown in Table 2. Older children were more likely to use both strategies ($\chi^2=8{\cdot}21$, $df=2$, $P<{\cdot}05$), as were efficient compared with inefficient children ($\chi^3=4{\cdot}95$, $df=1$, $P<{\cdot}05$).

TABLE 2

NUMBERS OF SUBJECTS USING BOTH ORIENTATION AND POSITION STRATEGIES.

Grade	3	5	7
efficient	3	6	10
inefficient	1	4	5

DISCUSSION

As in related tasks, the ability to co-ordinate perspectives increases with age. Although older children may elect to use either a position or an orientation strategy, younger children who use the position strategy are more likely to be successful. In general, children tended to use one or other strategy, although the incidence of relying on more than one increased with age. This occurred despite the close interdependence between the two strategies, given the specific aspects of our task, and may suggest that part of the older child's success is in recognising this interdependence and being able to co-ordinate information of both types, rather than rely on orientation or position information alone.

Within the sub-categories of orientation questions, we found that the incidence of questions concerned with the back or the front of objects increased with age. At the same time, the use of questions about features of objects was very high by all children, and was also especially associated with lack of success for grade 3 children. This was largely the result of younger children continuing to ask questions about features of objects, without inferring, for example, that if the mouse's eyes were visible, then so must be his nose. This is apparently reminiscent of the strategy of stimulus preference reported by Levine (1974), younger subjects preferring one aspect of the stimuli, and selecting to ask about this rather than adopt a more goal-orientated strategy. In commenting on the incidence of sub-categories of orientation questions, we also note that ' external reference ' questions were very infrequent. This suggests that subjects were not trying to solve the task using topological cues to spatial relations, and we well may have expected greater occurrence of this strategy given Piaget's hypothesis that children at first organise space within a topological framework.

The high incidence of an orientation strategy may be taken as support for the finding by Coie *et al.* (1973), that children first solve co-ordination of perspective tasks by focusing on *how* objects are seen, and only later attend to *where* they are seen. If the preference for an orientation strategy is a general approach in co-ordination of perspectives tasks, it may well explain some of the anomalies in previous literature. The age at which children succeed on these tasks has been reported as decreasing when the number of cues to orientation are high. Thus, where Fishbein *et al.* (1972) used stimuli high in orientation cues (e.g., toy dolls), it was reported that 3–4-year-olds were successful. Using three irregular mountains with some additional features containing orientation information (e.g., sheep), Piaget and Inhelder (1956) reported that children did not tend to succeed till 9–10 years. Finally, using stimuli completely devoid of cues to orientation (three symmetrical cones), Laurendeau and Pinard (1970) suggested that 11–12 years was the critical age. Removal of cues to orientation, therefore, appears to increase the difficulty of the task, and the age at which children are generally able to solve it.

One ambiguity in this analysis has, however, been in the definitions of the orientation and position aspects of space, particularly that of orientation. This can refer to the direction in which an object is facing, and can be defined as it projects on to other fixed objects in the immediate space—" it is looking toward the mushroom," *or* how an object projects to the observer—" It is looking toward me." In the analysis we included questions of both types in the orientation category. Although one implies the other, there remains some ambiguity in interpreting the emphasis placed by the child on the two alternatives. The contributions of orientation or position aspects of space to the child's knowledge rests, however, on a more precise definition of these terms.

The prevalence of the ' orientation ' strategy, coupled with the results of Coie *et al.* (1973), suggests that the child may acquire an orientational system prior to a positional one. The question of whether this is a necessarily invariant sequence is beyond the scope of these data. However, one anomaly is that, according to Pufall and Shaw (1973), knowledge of orientation aspects of space develops *after* knowledge of position. Once again, it appears to be crucial to define the aspects of space more precisely, if their relative contributions to the development of the child's spatial awareness can be assessed.

Research in progress is examining the generalisability of these findings beyond the specific stimuli and response mode employed. Within the context of the present paradigm, however, it is clear that children had reasonable ideas about the kind of information which would enable them to solve the task, even if they did not always draw correct inferences from it. The low number of irrelevant questions is particularly noteworthy, since any subjects who were wholly or partially egocentric, would presumably not have been aware of which questions they would need to ask in order to predict another's viewpoint. The correlation between the accuracy of children's responses and their responses on the pre-task (Flavell *et al.* 1968), suggests, however, that our task may involve cognitive skills common to other tasks of co-ordinating perspectives. It may, therefore, be reasonable to infer that the processes underlying success or failure can be examined without assuming that children who fail are necessarily egocentric, or fixated on their own point of view. Future research needs to be directed at the question of if, or how, children co-ordinate perspectives in the total absence of cues to orientation information.

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INTEREST, MENTAL HEALTH, AND ATTITUDINAL CORRELATES OF ACADEMIC ACHIEVEMENT AMONG UNIVERSITY STUDENTS

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SUMMARY. The relationships between three levels of academic achievement and various interest, mental health, and attitudinal variables were examined. Using the regression equation method, a sample of 239 students enrolled in introductory psychology were assigned to a high-achieving, average-achieving, or low-achieving group. The classification of each student was based on the relationship between his actual grade point average (GPA) in introductory psychology and the GPA which would be expected on account of his IQ score. All subjects completed the Strong Vocational Interest Blank for Men/Women, the Minnesota Multiphasic Personality Inventory, and the Student Interest and Attitude Study II. Two separate factor analyses, one for men and one for women, were carried out on all variables which differentiated significantly and systematically between the high-, average-, and low-achieving groups. For men seven factors were identified, for women only two factors. Especially noteworthy was the small number of interest variables which differentiated between the high-, average-, and low-achieving women.

INTRODUCTION

IN a recent study on academic achievement at the university level Banreti-Fuchs (1975) demonstrated a positive relationship between level of academic achievement and degree of mental health as measured by the Minnesota Multiphasic Personality Inventory. High-achievers came closest to the population average on the MMPI scales, low-achievers deviated furthest from the population average in a negative direction, while average-achievers received scores falling between those of the high- and the low-achievers. These results did not seem to support the claims of Furneaux (1962) and Kelvin, Lucas, and Ojha (1965) who suggested a positive relationship between neuroticism and academic achievement at the university level. The personality picture of the high-achievers emerging from this study, however, confirmed the findings of Lavin (1965), Entwistle and Entwistle (1970), Entwistle and Brennan (1971), and Entwistle (1972), who had described high-achievers as essentially stable introverts. The results were also consistent with the findings of Davids *et al.* (1968), Desiderato and Koskinen (1969), Spielberger (1966), Barton *et al.* (1972), and Kohn and Rosman (1974) on the negative effects of anxiety and emotional instability with regard to academic achievement. Also the important positive role of motivation, study habits, and task orientation was confirmed, as previously demonstrated by, among others, Finger and Schlesser (1965), Khan (1969), Herrenkohl (1972), and Entwistle (1972).

The present study was designed to investigate further the correlates of academic achievement, with special emphasis on interest, mental health, and attitudinal variables. Compared to the previous studies by the senior author (Banreti-Fuchs, 1972, 1975) several major changes were made. Firstly, an important part of the study was based on the role of interest variables. Secondly, the responses of the male and female subjects were analysed separately in order to assess potential sex differences. Thirdly, the comparisons between the high-achieving, average-achieving, and low-achieving groups were not based on a small number of scales, such as the F, Hs, D, Pd, Pt, Sc, and Ma scales of the Minnesota Multiphasic Personality Inventory which previously had been shown to differentiate between the three achievement levels (Banreti-Fuchs, 1975), but every single item of the tests used was considered independently. Since the method of considering each item separately may result in a relatively large number of items statistically significant on the basis of chance alone, it should be pointed out clearly that only those significant items were used in the factor analyses which discriminated between the three achievement levels in a systematic order. This means that the average-achieving group had to be between the high-achieving and the low-achieving groups in the response distribution. This additional condition reduces the number of discriminating items, whose significance may be based on chance alone, by two-thirds.

METHOD

114 male and 125 female students enrolled in introductory psychology were asked to complete the Dominion Test of Learning Capacity (Advanced, Form A) (Ontario Institute for Studies in Education, 1970), the Strong Vocational Interest Blank for Men/Women, the Minnesota Multiphasic Personality Inventory, and the Student Interest and Attitude Study II (Banreti-Fuchs, 1973). Administration of these instruments took place in small groups, spread over several sessions. Subsequently, all students were classified as high-, average- or low-achievers. Assignment to one of the three groups was based upon the regression equation method (Guilford, 1956), using the subjects' IQ scores and their grade point averages (GPAs) in introductory psychology. Those students whose actual GPAs were between plus and minus 0·7 standard error of estimate from their expected GPAs were classified as average-achievers. Students whose actual GPAs were 0·7 standard error of estimate or more above their expected GPAs were classified as high-achievers, while students whose actual GPAs were 0·7 standard error of estimate below their expected GPAs were classified as low-achievers. A standard error of estimate of 0·7 was chosen in order to have a sufficient number of subjects in the high-, and the low-achieving groups.

Item analysis was carried out on the responses of the three achievement groups to all items of the three instruments. Only those items which discriminated significantly ($P < \cdot 05$, two-tailed) between the high-, average-, and low-achieving groups in the systematic manner already mentioned (Appendix 1 and 2) were subjected to factor analysis using the principal component solution and the varimax rotation method (Kaiser, 1958). In deciding which variables to consider in the interpretation of the factors, a factor loading of $\pm 0 \cdot 40$ was chosen as the cut-off score, which was the same as in two previous studies on academic achievement by the senior author (Banreti-Fuchs, 1972, 1975). Separate factor analyses were carried out for males and females.

A problem inherent in the use of correlational techniques in general should be kept in mind when evaluating the results of this project. It would be unjustified to draw conclusions regarding cause-and-effect relationships. In the absence of experimental evidence, only the gradual accumulation of supportive data from a variety of sources will make assumptions on cause-and-effect relationships increasingly more justified.

RESULTS AND DISCUSSION

The Pearson product-moment correlation between IQs and GPAs for the 239 subjects produced an $r=0{\cdot}34$ ($P<{\cdot}001$). Based on the regression equation method (Guilford, 1956), 60 subjects were classified as high-achievers, 127 as average-achievers, and 52 as low-achievers (Table 1). As expected, the three achievement groups did not differ significantly in average age or IQ, but were highly different in average GPA.

TABLE 1

MEAN SCORES AND STANDARD DEVIATIONS BY ACHIEVEMENT GROUP.

Measure	High Achievers (N=60) Mean (SD)	Average Achievers (N=127) Mean (SD)	Low Achievers (N=52) Mean (SD)	P*
Age	20·2 (2·3)	20·0 (1·5)	20·7 (1·8)	0·13
Learning Capacity . .	108·0 (12·9)	107·0 (11·6)	108·2 (13·3)	0·81
Grade Point Average	81·8 (5·6)	69·1 (5·1)	55·6 (6·4)	<0·01

* Analysis of Variance.

TABLE 2

ROTATED FACTOR MATRIX OF MALES.

		Factors							
Variable*		I	II	III	IV	V	VI	VII	h²
Physical Health	(S 19)	·04	·27	·04	—·01	·03	·16	·23	·16
Parents nag	(S 20)	·11	·11	·10	·01	·04	·00	—·10	·05
Estimated mark	(S 35A)	*·77*	—·04	·12	—·06	—·16	·24	—·08	·70
Estimated marks	(S 35C)	*·78*	·22	·00	·09	·06	·13	—·07	·69
Postgraduate aspirations	(S 65)	·25	—·11	—·15	—·03	·09	*·67*	—·15	·58
Optimistic	(S 133)	—·08	·02	·03	—·00	·07	·02	·04	·01
Biblical prophecy	(M 58)	—·11	·37	—·06	—*·62*	—·02	—·09	—·27	·62
I'm important	(M 73)	—·08	—·17	—·22	·15	*·70*	—·16	—·08	·63
Like dramatics	(M 126)	—·37	—·06	—·23	—·01	*·42*	·11	—·16	·41
No heart pounding	(M 230)	·06	·03	*·57*	—·11	·02	·13	—·22	·41
No dolls	(M 300)	—·23	—·08	·11	—·11	·08	—·21	—·05	·14
Satisfactory sex	(M 310)	—·09	·13	·20	*·58*	—·13	·04	—·12	·43
Never in love	(M 324)	·02	·04	·24	·03	—·08	*·58*	·14	·42
Never drugs	(M 466)	—·16	*·44*	—·13	·11	—·06	—·14	·—01	·27
Usual urination	(M474)	·17	·36	·24	—·01	—·21	—·06	·00	·26
Read Bible	(M 490)	—·04	·16	·27	·35	·00	*·50*	·20	·51
Daydream	(M 511)	·30	*·73*	·19	—·00	—·06	—·07	—·12	·68
Mother attachment	(M 562)	—*·50*	·23	—·15	·10	—·02	·17	—·36	·49
Like basketball	(V 60)	·00	—·11	—·10	·02	—·04	·03	·33	·13
Like school teaching	(V 82)	—·02	·18	—·35	*·57*	·06	—·07	—·06	·49
Like drill	(V 123)	—·12	·02	—*·69*	—·09	·02	—·05	·08	·51
Like hunting	(V 139)	—·00	*·49*	—·06	·01	—·11	·22	·12	·32
Like competition	(V 222)	—·02	·25	—·15	—·00	·03	·06	*·78*	·70
Like thrift	(V 247)	·07	·03	·29	—·22	*·72*	·08	·11	·68
Definite salary	(V 335)	—·12	—·14	·10	—·21	—·07	—·08	·26	·17
Start activities	(V 361)	—·03	—·02	—·11	·05	·08	—·10	—·11	·04

* Full items are shown in Appendix 1.

	I	II	III	IV	V	VI	VII
Percentage of variance	20·8	12·4	11·5	10·1	9·8	9·0	7·8

Total variance accounted for: 81·4 per cent.

Item analysis for males revealed 26 variables which discriminated systematically between the high-, average-, and low achieving groups. Of these 26 variables, six were from the Student Interest and Attitude Study II (S), 12 from the Minnesota Multiphasic Personality Inventory (M), and eight from the Strong Vocational Interest Blank for Men (V).

Item analysis for females revealed only 13 variables which discriminated systematically between the high,- average-, and low-achieving groups. Of these 13 variables, six were from the Student Interest and Attitude Study II (S), four from the Minnesota Multiphasic Personality Inventory (M), and three from the Strong Vocational Interest Blank for Women (V).

Factor analysis for *males* indicated seven factors which account for 81·4 per cent of the variance.

Factor 1, which accounts for 20·8 per cent of the variance, identifies attitudes toward academic achievement and early mother-child relationships. High-achievers anticipate to earn relatively high GPAs, while low-achievers expect to receive poorer marks. High-achievers also feel that in their childhood years they have had a close mother-child relationship, while low-achievers express this feeling to a much lesser extent.

Factor 2 accounts for 12·4 per cent of the variance and identifies attitudes toward social conformity, independence, and kind of leisure activity enjoyed. High-achievers tend to conform to society's rules, but within the context of those rules they like to be rather independent and enjoy non-aggressive leisure activities.

Factor 3 accounts for 11·5 per cent of the variance and identifies attitudes toward one's body and physical exercise. High-achievers tend to be more aware of physical dysfunction and less oriented toward physical exercise. They are less body-culture oriented than low-achievers.

Factor 4 accounts for 10·1 per cent of the variance and identifies attitudes toward social values. High-achievers tend to be rather traditional and puritanical in their values. They do not emphasise the role of sexuality and are not particularly spontaneous in their overt social-personal relations.

Factor 5 accounts for 9·8 per cent of the variance and identifies attitudes toward the self, depth of human relations, and self-control. High-achievers have a more positive self-concept, they are interested in the deeper rather than the superficial aspects of human relationships, and exercise a higher degree of self-control.

Factor 6 accounts for 9·0 per cent of the variance and identifies attitudes toward goal-orientation, love, and religion. High-achievers tend to have more ambitious goals, are less likely to fall in love, and are more interested in reading the Bible. In other words, they are more ambitious and reflective, and more restrained in their interaction with the other sex.

Factor 7 accounts for 7·8 per cent of the variance and identifies attitudes toward competition. High-achievers tend to like competitive activities less than low-achievers.

If one wishes to summarise the characteristics of the high-achieving *male*, as found in this study, the following description would apply. He is a person who, as a child, has had a close, positive relationship to his mother. He is goal-oriented and expects to do well academically. In his social values he is rather conformist, accepts the rules of society, but within this context he is nevertheless independent-minded. He dislikes aggressive forms of entertainment, like hunting, and is not body-culture oriented. His personal values are rather puritanical, he exercises a high degree of self-control, and his sexual interests are somewhat in the background. He is rather reflective and interested in the deeper aspects of interpersonal relationships. Although he is ambitious and has a positive opinion of his abilities, he is not particularly keen on competing with others. On the whole, he emerges as a somewhat colourless, but nevertheless stable, active, assertive, and task-oriented individual who is well-organised and is in general a rather solid and mentally healthy person.

The results of the factor analysis for *females* consist of two factors only and account for 54·0 per cent of the total variance.

TABLE 3

ROTATED FACTOR MATRIX OF FEMALES

		Factors		
Variable *		I	II	h²
Estimated mark	(S 35A)	*·83*	—·13	·71
Estimated marks	(S 35C)	*·89*	—·06	·80
High intelligence	(S 37)	*—·45*	*·44*	·40
Absent from classes	(S 42)	—·12	—·05	·02
Important to like professor	(S 87)	·04	—·15	·02
Relaxed	(S 115)	—·02	·08	·01
Don't sleep well	(M 43)	·09	—·05	·01
Can't think in group	(M 267)	—·16	·08	·03
Paranoia	(M 293)	—·05	·04	·00
No enemies	(M 347)	—·02	*·79*	·62
Fashion model	(V 62)	—·04	·37	·14
Mechanics magazines	(V 151)	·11	—·18	·04
Like to be alone	(V 208)	—·14	·39	·17

* Full items are shown in Appendix 2.

Percentage of Variance 33·1 20·9

Total variance accounted for: 54·0 per cent.

Factor 1 accounts for 33·1 per cent of the variance and identifies expectation of academic success, and perception of one's intelligence. High-achieving women expect to be more successful in terms of academic achievement and perceive their intelligence as above-average. This factor is somewhat similar to Factor 1 for males.

Factor 2 accounts for 20·9 per cent of the variance and identifies perceived intelligence and attitude toward others. High-achievers tend to perceive themselves as having above-average intelligence and see others as friendly, non-threatening.

If we wish to describe high-achieving *women* on the basis of these data, all we can say is that they tend to perceive themselves as above-average in intelligence, expect to do well academically, and seem to be relatively free of anxiety in interpersonal relationships. In other words, they have a rather positive self-concept with regard to their intelligence, expect to be successful academically, and have a positive attitude toward social interaction.

In addition to confirming the role of mental health variables in academic achievement, the results of this project are interesting in several respects. They underline the modest role of interest variables as a factor in discriminating between the high-achieving, average-achieving, and low-achieving males, and demonstrate the fact that in the case of women interest variables seem to be nearly irrelevant in determining level of academic achievement. As a possible explanation for this apparent lack of importance of the interest variables for discriminating between various levels of academic achievement, it could be hypothesised that the Strong Vocational Interest Blank for Men/Women is perhaps an inappropriate instrument for measuring interests at the university level. It is more likely, however, that level of academic achievement is dependent upon well-entrenched acquired traits and habits, which have gelled into a rather stable style of life for which interests as such are a relatively unimportant dimension. As to why interests should be even less important as correlates of academic achievement in women as compared to men, is by no means clear. As a tentative explanation it could be argued that those women who are ambitious enough to take up higher education will display greater dedication to the task and a more consistent performance than their male colleagues. This hypothesis would, at least, be consistent with previous findings concerning factors which affect level of academic achievement in men *versus* women. E.g., "attending lectures regularly" was an important variable discriminating between high-achieving, average-achieving, and low achieving men, but not at all among women. Identical results were also found with variables such as "paying attention when not interested in the subject," or "putting in time on studying even when not getting anywhere" (Banreti-Fuchs, 1975). Female students seem to conform more to rules, regulations, and expectations regardless of their achievement level. It is, therefore, not unlikely that interests would have less impact upon level of academic achievement as discriminating variables among women than among men.

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APPENDIX 1

Percentage distribution of the *affirmative responses* of the high-achieving (H), average-achieving (A), and low-achieving (L) males to the discriminating items.

Item No.	Item	L	A	H
S 19	Would you rate your physical health above average in comparison to people your own age?	82·3	50·0	37·5
S 20	Do your parents (father or mother) nag you about the importance of obtaining a higher education frequently?	32·2	25·9	6·2
S 35A	Give an estimate, in terms of percentages, what your final mark will be this year in your introductory psychology course	61·4	66·3	73·5
S 35C	Give an estimate, in terms of percentages, what your final mark will be this year (overall average of all your courses)	65·3	67·8	72·0
S 65	Do you expect to go further than a B.A. in your university education?	17·6	51·9	62·5
S 133	Are you very optimistic regarding your own future?	8·8	19·2	56·2
M 58	Everything is turning out just like the prophets in the Bible said it would	12·5	13·3	50·0
M 73	I am an important person	33·3	53·3	81·8
M 126	I like dramatics	36·8	43·8	81·8
M 230	I hardly ever notice my heart pounding and I am seldom short of breath	84·2	59·4	36·4
M 300	There never was a time in my life when I liked to play with dolls	72·2	67·7	27·3
M 310	My sex life is satisfactory	94·1	65·6	18·2
M 324	I have never been in love with anyone	5·6	12·9	45·5
M 466	Except by a doctor's orders, I never take drugs or sleeping powders	35·3	46·9	81·8
M 474	I have to urinate no more often than others	94·1	93·8	63·6
M 490	I read the Bible several times a week	0·0	3·3	27·3
M 511	I have a daydream life about which I do not tell other people	11·1	25·0	54·5
M 562	The one to whom I was most attached and whom I most admired as a child was a woman (mother, sister, aunt, or other woman)	18·8	35·5	72·7
V 60	I would like the work of a professional baseball player	79·3	55·8	41·7
V 82	I would like the work of a school teacher	48·3	39·5	8·3
V 123	I like military drill	17·2	14·0	0·0
V 139	I like hunting	72·2	61·9	33·3
V 222	I like competitive activities	96·6	67·4	50·0
V 247	I like thrifty people	29·6	47·6	66·7
V 335	I would like a definite salary	41·4	79·1	83·3
V 361	I usually start activities of my group	41·4	46·5	58·3

APPENDIX 2

Percentage distribution of the *affirmative responses* of the high-achieving (H), average-achieving (A), and low-achieving (L) females to the discriminating items.

Item No.	Item	L	A	H
S 35A	Give an estimate, in terms of percentages, what your final mark will be this year in your introductory psychology course	63·0	65·8	71·0
S 35C	Give an estimate, in terms of percentages, what your final mark will be this year (overall average of all your courses)	63·6	66·8	71·0
S 37	Are you above average in intelligence?	0·0	10·9	25·0
S 42	Have you been absent from classes less than one week this year?	69·2	90·6	90·9
S 87	Is it important to like the professor?	76·9	53·8	36·4
S 115	Are you relaxed?	84·6	76·9	63·6
M 43	My sleep is fitful and disturbed	37·5	28·9	8·1
M 267	When in a group of people I have trouble thinking	25·0	29·2	67·6
M 293	Someone has been trying to influence my mind	42·9	10·6	5·4
M 347	I have no enemies who really wish to harm me	75·0	95·8	100·0
V 62	I would like the work of a fashion model	22·2	46·0	71·4
V 151	I like popular mechanics magazines	33·3	4·0	2·9
V 208	I like being left to myself	33·3	55·1	74·3

RESEARCH NOTES

Br. J. educ. Psychol., 46, 220-222, 1976

PERSONALITY AND ACADEMIC ATTAINMENT : A CROSS-CULTURAL STUDY

By C. ORPEN

(*University of Witwatersrand, South Africa*)

SUMMARY. This study examines the 'age effect' hypothesis from British and American studies, that academic success at primary school is linked to stable extraversion while success at university is associated with introversion, with black and white school children (age 14) and black and white university students (age 20), brought up in non-Western and Western cultures, respectively. The extraversion and neuroticism scores of the subjects on the JEPI or the EPI were compared to their academic success, given by their performance in school or university examinations. The results supported the 'age effect' hypothesis in both white and black groups.

INTRODUCTION

In a seminal article Entwistle (1972), after a thorough review of the literature, concluded that at the later secondary and university level, introverts, possibly the more unstable ones, are likely to perform better than extraverts. However, at the early secondary and primary school level, the stable extravert is likely to outperform the unstable introvert. Warburton's (1968) detailed review also revealed this age trend, and concluded that it is at approximately 18 that this 'change-over' occurs. In a recent cross-cultural study in Uganda, Honess and Kline (1974) found similar relations to those reported in Britain and America, with the stable extraverts in their sample of 14-year-olds and the unstable introverts in their sample of 17-year-olds tending to do better than the others. These similar results prompted the present study, which was designed to examine the relationships between extraversion, neuroticism and academic attainment in two different South African groups, deliberately chosen because of their adherence to unlike cultural norms and values.

PROCEDURE

The subjects were either Xhosa-speaking Blacks or Afrikaans-speaking Whites in South Africa. The socio-cultural conditions of these two groups are in striking contrast, with the Xhosas being an important segment of the disadvantaged black population (Morse and Orpen, 1975). The black group was divided into two sub-groups; the first consisted of 46 males and 36 females attending a rural secondary school in a 'tribal' area of South Africa, and the second of 38 males and 31 females attending one of the so-called 'tribal' colleges or universities established by the South African government exclusively for blacks. The average age of the black school sample was 14·6 years and that of the black university sample 20·2 years. None of the subjects in the two black samples or sub-groups had ever lived in a city or town of 'white' South Africa. The white group was also divided into two sub-groups; the first consisted of 48 males and 40 females attending a rural secondary school in a predominantly 'Afrikaans' area of South Africa, and the second of 40 males and 41 females attending an Afrikaans-medium university. The average age of the white school sample was 14·0 years and that of the white university sample 19·6 years. None of the subjects in the two white samples or sub-groups had ever lived in an area where English was the main language of the inhabitants.

In view of their lack of expertise in English, the subjects completed specially-devised Xhosa and Afrikaans versions of the Eysenck Personality Inventory (EPI) and the Junior Eysenck Personality Inventory (JEPI). The two school samples completed the JEPI and the university samples the EPI. Studies with the EPI have shown that it is fairly valid with both Xhosa subjects (Orpen, 1975) and with Afrikaans subjects (Orpen, 1972).

Academic attainment was given by the average percentage marks obtained by the subjects in their year-end examinations. All the subjects in a given sample or sub-group took the same examinations. Both the black and white school children took general examinations in their first language, English, Mathematics, History and Geography and Science. Both the black and white students were enrolled for Bachelor of Arts degrees, majoring in either Afrikaans or Xhosa. The Standard Six examinations taken by the black and white school samples were of a comparable standard, as were the first-year university examinations taken by the black and white student samples.

To examine the relations between personality and academic attainment, correlations were computed between the extraversion and neuroticism scores of the subjects in each of the four samples and their performance in the year-end examinations. Separate correlations were computed for males and females in each sample. The results of these computations are given in Table 1.

TABLE 1

CORRELATIONS BETWEEN EXTRAVERSION (E), NEUROTICISM (N) AND ACADEMIC ATTAINMENT.

Group	Males		Females	
	E	N	E	N
White students	−·16 (40)	+·09 (40)	−·30* (41)	+·14 (41)
Black students	−·36* (38)	+·22 (38)	−·28* (31)	+·31* (31)
White school children........	+·27* (48)	−·14 (48)	+·20 (40)	−·27* (40)
Black school children	+·32* (46)	−·29* (46)	+·28* (36)	−·14 (36)

* P< ·05

Sample sizes shown in parentheses.

RESULTS AND DISCUSSION

With the black and white school children, three of the four correlations between extraversion and academic success were significant (P< ·05). Only the correlation between extraversion and academic success among the white females failed to reach significance. This finding supports those of Honess and Kline (1974) in Uganda and that of Entwistle and Cunningham (1968) in Britain. The finding of Honess and Kline (1974) of a stronger relationship among female subjects was not replicated. In fact, slightly higher correlations were found for males. The contrast to these findings, among the black and white university students, three of the four correlations between extraversion and academic success were significantlynegative (P< ·05). The finding that introversion is associated with university success agrees with the findings of the English studies reviewed by Warburton (1968) and the American studies reviewed by Lavin (1967).

These results, in short, offer cross-cultural support for the view that extraversion is more important for success at school and introversion for university success. It is noteworthy that the change-over was more marked for the black samples than for the white samples. Among the black subjects, both the correlations were significantly positive ($P < \cdot 05$) in the school sample, and significantly negative ($P < \cdot 05$) in the university sample. Among the white subjects, on the other hand, only one of the two correlations was significantly positive ($P < \cdot 05$) in the school sample and one significantly negative ($P < \cdot 05$) in the university sample. Although the present data do not supply the reason for this difference, it probably is related to the fact that the black student sample is much more highly selected in terms of academic ability than is the white student sample, compared to their respective school populations. Very few of the black school-going population in South Africa proceed to full-time study at one of the three black universities. On the other hand, a relatively large proportion of Afrikaans school children continue their education at one of the six Afrikaans universities.

The relation between neuroticism and academic success is not as strong as that between extraversion and success. For instance, of the eight correlations only three were significant ($P < \cdot 05$). The two correlations that were significantly negative, indicating that stability is more important for success, were both at the school level, one among the whites and one among the blacks. The one correlation that was significantly positive, indicating that instability is more important for success, was at the university level, among the black females. An examination of the directions of the correlations revealed a consistent trend in both the white and black groups for stability to be associated with school success and instability or neuroticism with university success, although the overall relationship was fairly weak.

The most important general finding is that the pattern of relations between extraversion, neuroticism and academic attainment is similar in both the white and black groups, despite their very different socio-cultural backgrounds. In addition, these South African results are essentially similar to those found with Ugandan and British school children and to some, though not all, of those found with British and American university students. They can be regarded as offering firm cross-cultural support for the existence of the age effect, to which Entwistle (1972) drew attention.

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Br. J. educ. Psychol., 46, 223-225, 1976

EFFECTS OF STIMULI, ORDER OF PRESENTATION AND SEQUENCE ON CONSERVATION OF NUMBER : A METHODOLOGICAL NOTE

By J. J. ROBERGE and K. S. CLARK*

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SUMMARY. Errors in the analysis of data in Experiment I of a paper by Kahn and Garrison (1973) are reported. Appropriate strategies for analysing order and sequence effects are described and the Kahn and Garrison data are reanalysed using these methods.

In a recent study, Kahn and Garrison (1973) investigated possible differences in observed conservation of number due to the grade level of the subjects, the type of stimuli utilised, and the order of presentation of the stimuli. While the discussion of their findings is interesting and important, it is clouded by at least two noteworthy methodological errors in the first experiment. First, all of the subjects were presented with both types of stimuli (i.e., small candies and paper clips), but the ' Stimulus ' factor was incorrectly included as a between-subjects factor, rather than a within-subjects (or repeated measures) factor, in the analysis of variance.

Second, at each of the three grade levels (i.e., kindergarten, first grade, and second grade), one half of the subjects had trials with small candies followed by trials with paper clips and the other half had trials with paper clips followed by trials with small candies. However, the data were *not* analysed by using either a Latin square design that contained a within-subjects ' Order ' factor or a repeated measures design which included a between-subjects ' Sequence ' factor. Instead, the erroneous analysis which was presented in their article was a hybrid that contained some of the features of each of these designs.

Since the order effects were counterbalanced, in our initial reanalysis of the Kahn and Garrison data (see Table 1) we used a three-factor Latin square design (Grade Level × Stimulus × Order) with repeated measures on the last two factors. A discussion of the characteristics of such designs and/or the computational procedures can be found in statistics books commonly used by behavioural scientists (e.g., Bruning and Kintz, 1968, pp. 92-105; Lindquist, 1953, pp. 285-288; Myers, 1972, pp. 292-300; Winer, 1971, pp. 727-736). The results showed significant main effects for grade level and stimulus, and a significant interaction between the stimulus materials and their order of presentation.

TABLE 1

ANALYSIS OF VARIANCE FOR GRADE LEVEL, ORDER OF PRESENTATION, AND STIMULUS—EXPERIMENT I.

Source	df	MS	F
Between Subjects	59	—	—
Grade Level (A)	2	3·67	11·64**
B×C	1	3·01	9·53**
A×B×C	2	·01	·03
Error (between)	54	·32	—
Within Subjects	60	—	—
Stimulus (B)	1	·21	5·49*
Order (C)	1	·01	·22
A×B	2	·01	·22
A×C	2	·11	2·85
Error (within)	54	·04	—

* P< ·05. ** P< ·01.

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* The authors gratefully acknowledge the co-operation of Dr. James V. Kahn who provided them with a copy of the data collected in the first experiment reported by Kahn and Garrison (1973).

As an alternative data analysis strategy (see Table 2), we used a three-factor design (Grade Level × Sequence × Stimulus) with repeated measures on the third factor. Designs involving a between-subjects 'Sequence' factor are also described in behavioural science statistics books (e.g., Kirk, 1968, p. 317; Winer, 1971, pp. 576-577). As expected, the results indicated significant main effects for grade level and stimulus. Moreover, there was a significant main effect for sequence.

TABLE 2

ANALYSIS OF VARIANCE FOR GRADE LEVEL, SEQUENCE, AND STIMULUS—EXPERIMENT I.

Source	df	MS	F
Between Subjects	59	—	—
Grade Level (A)	2	3·67	11·64**
Sequence (C)	1	3·01	9·53**
A×C	2	·01	·03
Error (between)	54	·32	—
Within Subjects	60	—	—
Stimulus (B)	1	·21	5·49*
B×C	1	·01	·22
A×B	2	·01	·22
A×B×C	2	·11	2·85
Error (within)	54	·04	—

$^*P < \cdot05$. $^{**}P < \cdot01$.

A comparison of Tables 1 and 2 reveals an important characteristic of these analyses for experiments involving two treatment levels and orders of presentation. Specifically, there is a one-to-one correspondence between the sources of variation in these tables such that all of the statistics for the corresponding sources are *identical*. For example, the statistics for the 'Stimulus × Order' interaction in Table 1 correspond to those for the 'Sequence' main effect in Table 2, and the statistics for the 'Sequence × Stimulus' interaction in Table 2 are equal to those for the 'Order' main effect in Table 1. The researcher who is aware of these facts could perform either of the analyses described above, provided that the underlying assumptions are met, and should better understand the relationships between order and sequence effects.

In experiments involving more than two treatment levels and orders of presentation, the isomorphism between these two analyses would be less apparent. Furthermore, when the number of treatment levels is five or more, the number of possible sequences is prohibitively large. Thus, if the researcher is interested in examining order effects, a Latin square could be used to counterbalance the order in which each of the treatment levels appears within the sample of sequences that are used in the experiment. More precisely, each treatment level would appear equally often in each of the orders. On the other hand, if the researcher wanted to study sequence effects, then a sample of the sequences could be employed and a 'Sequence' factor could be built into the design.

In conclusion, this methodological note corrects errors in Experiment I of the Kahn and Garrison study, and illustrates procedures for analysing data involving order and/or sequence effects. Educational researchers interested in exploring these issues in greater depth would be well advised to study the comprehensive papers by Gaito (1961) and Benjamin (1965), and the discussion of order and/or sequence effects presented in behavioural science statistics textbooks (e.g., Keppel, 1973; Kirk, 1968; Lindquist, 1953; Myers, 1972; Winer, 1971).

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COMMENTS ON THE ROBERGE AND CLARK ARTICLE

BY J. V. KAHN

I would like to thank Roberge and Clark for pointing out a methodological error, in my article (Kahn and Garrison, 1973), which I inadvertently made. They are quite correct in pointing out that the 'Stimulus' factor should have been treated as a within-subjects factor rather than a between-subjects factor. Indeed, I did treat the ' Stimulus ' factor as a within-subjects factor in a subsequent investigation (Kahn and Reid, 1975).

I would like to point out that the different statistical treatment, used by Roberge and Clark, while important, does not alter the conclusions of the original study. The major difference between the original and present findings is the present finding of a significant main effect for ' Stimulus.' This would be primarily explained by the significant interaction between ' Stimulus ' and ' Order ' which was found in both analyses and was discussed in detail in the original study.

Finally, I would like to thank the editor for informing me of the Roberge and Clark manuscript and for allowing the preceding comments.

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BOOK REVIEWS

BERENBERG, S. R. (Ed.) (1975). *Puberty : Biologic and Psychosocial Components.* Leiden: H. E. Stenfert Kroese B.V., pp. 320, Dfl. 68·00.

This collection of papers derives from a conference held in December, 1974. The contents are very diverse and include seven concerned with the biochemistry of hormones, twelve concerned with general physical manifestations of puberty and their psychological concomitants, three relating to cognitive changes during adolescence and a further three on emotional changes.

The biochemistry of hormones, particularly the dynamics of the diminishing feedback system between gonadal steroids and the CNS is treated in great detail in a number of papers. The studies are complex and are unlikely to be of more than general interest to the average psychologist. The reviewer confesses to the somewhat rueful observation that the precision with which the mechanisms are described is in marked contrast to psychological interpretations of dynamic systems.

Amongst the more general papers are a number on obesity, a common feature of adolescence, and one which gives rise to more than its share of emotional crises in western cultures. Heald and Khan summarise the evidence that obesity in early childhood is of a different nature to that of the later period, Knittle concludes that there may be critical periods for each of these forms, one between birth and two years, the other occurring in the prepubescent and adolescent period.

Tanner, whose pre-eminence in the field of physical development at puberty is attested by the presence of his name in almost every other paper in the collection, presents a joint paper with Eveleth. It provides a fascinating adjunct to the general cross-cultural trends to early puberty which he published in 1962. The present paper is concerned with variations between populations in the timing of various events of puberty and the links between them. Social class and urban/rural differences are related to some differences in skeletal development and menarche respectively, although on the whole there are more differences between Europeans and non-Europeans than there are within each group. Evidence is adduced to suggest that these differences are due to genetic rather than environmental effects. The authors admit that studies of this sort are relatively recent, and this probably accounts for the rather fragmentary impression given.

Papers on cognitive development include two by British contributors, Peel and Wall. Wall's is short, stressing his view that much of the cognitive development of later adolescence is dependent upon a high mental age and pedagogic influences. His emphasis upon the learned aspects of adolescence is in contrast to Peel's paper. Peel pursues his now familiar work on explainer thinking and abstraction and generalisation, elaborating some environmental factors related to them, but with further analyses suggesting a maturational effect. Curiously, his conclusion that " the largely maturational factor of readiness would then seem to be a prior condition . . . in making an intellectual judgment " does not feature in his recommendations to teachers, in which he emphasises the need to grade work and build up to hypothetico-deductive thinking rather than the need to ascertain that maturation has occurred.

There are a number of minor irritants in the book. One or two of the papers are in French, some of the papers are very brief, suggesting rather ruthless summarising, and interpolated commentaries from participants make nonsense when either questions are given without answers or *vice versa.* Nevertheless there is much of interest to the student of adolescence. The collection is warmly recommended.

G. BROWN.

BROWN, G. (1975). *Microteaching: A Programme of Teaching Skills.* London: Methuen, pp. 163, p. £3·60, c. £7·00.

This book gives an account of a systematic programme of teacher training which, according to the author, is intended to help " students and young teachers develop their basic teaching skills." It does not, as its title suggests, devote itself to microteaching and the use of different microteaching models.

The book is divided into three sections. Sections one and three appear to be addressed to teacher trainers rather than to their students. The first includes a brief discussion of teacher education and training while the third is concerned with ways of setting up a microteaching programme. Section two, which comprises two-thirds of the book, is a students' manual concerned with lesson planning, perceiving teaching and the skills of exposition, questioning and discussion. " Activities " for the student include the planning of micro-lessons, the use of a simplified interaction analysis system and exercises based on scripts of teaching interactions.

The modified form of microteaching used in this course differs from ' microteaching,' as defined by Allen and Eve and used in well-known modifications of the Stanford model, in not restricting microteaching practice to specific skills which can be defined in behavioural terms. Instead it includes teaching skills which are defined in such global terms as ' lesson-planning ' and ' perception of teaching.' This modification leads to less structured analyses of micro-lessons and more emphasis on evaluation of microteaching in the form of general observations.

This volume will be of interest to those who are already acquainted with microteaching, but is not the ideal introduction to this subject for those who are not. As a description of a systematic training course for teaching, based on practical experience with students, it will provide a useful source of discussion, information and reference for those concerned with teacher education.

ELIZABETH PERROTT.

CHANAN, G., and DELAMONT, S. (Eds.) (1975). *Frontiers of Classroom Research.* Slough: N.F.E.R., pp. 266, £5·65.

This is a collection of papers from two seminars, held in 1973 and 1974, to discuss the state of classroom research in Britain. The papers fall into three main categories: two research reviews, four theoretical contributions on the ' state of the art ' and eight accounts of research projects.

In the first review Wragg covers the development of classroom research in Britain and provides a useful background paper for newcomers to this field. The second review is devoted to ' microteaching,' but in this case is not confined to British work. In his use of the term ' microteaching' Brown departs from the definition used to describe the original Stanford model in which the practice of specific skills is a vital part. Brown enlarges this definition to include any small-group teaching where arrangements for feedback and its analysis have been made. As a result studies which conceive microteaching in very different terms are reviewed, without guidance for the uninitiated on the nature of these differences. In the interests of clarity it might have been wiser to devise another term to describe small group teaching in which the focus is not on the practice of specific skills.

The theoretical contributions include (1) a lengthy paper by Eggleston and his co-workers in which a taxonomy of observation strategies is attempted; (2) a lively discussion of the *pros* and *cons* of studying informal classrooms by case-study methods by Adelman and Walker ; (3) an exploration of problems of the classroom setting as a unit of analysis in observation studies by Poppleton and (4) a consideration of the possibilities for integrating research and practice, which interaction studies offer, by Morrison. Although diverse, all these contributions raise issues which anyone contemplating classroom studies should consider.

Accounts of specific research projects form the major part of this book. All are alike in dealing with strategies which may be used in studying teaching, but in every paper a different approach to classroom phenomena is used. These range from an account of questionnaire surveys covering a wide range of classroom behaviour and leading to cluster analyses of teachers' responses (Bennett), to Stubbs' description of a sociolinguistic approach to classroom interaction. The papers also vary in that they include studies of primary school classrooms (Boydell, Bennett and Powell); secondary classrooms (Hannan and Woods) and aspects of higher education (Atkinson and McLeod *et al.*). In higher education the range is from clinical medical education to the professional education of intending teachers.

Inevitably in a book of this nature, contributions are uneven, but it presents a choice of approaches to suit most tastes. It should be a useful volume for the newcomer to classroom studies and would have been even more so had an index been included.

ELIZABETH PERROTT.

HOWE, M. (1975). *Learning in Infants and Young Children.* London: Macmillan, pp. 216, £6·95.

Dr. Howe has aimed his book at the exceedingly heterogeneous readership of " all those who have an interest in how the young are influenced by the world they experience " and discusses social learning and attachment, the influence of language on learning (but not language development as such) and individual differences in learning. He examines the ramifications of these studies via an account of some procedures aimed at accelerating learning. He ducks none of the problems inherent in such a task. He is explicit about the selections he has made from a vast literature; he discusses the problems of theoretical perspectives, measurement, inference and implication and is uncompromising about presenting psychology's best efforts even when these conclusions have an embarrassingly belated concurrence with well-established conventional wisdom. He notes, for example, that " crying by the infant is likely to be followed by contact with the mother. It is likely that crying by the infant influences the mother's behaviour, the mother's interaction with the child being reinforced by the cessation of the crying."

However, Dr. Howe's efforts to be scholarly, balanced and intelligible to a general audience, all within the confines of one little book, do not gel. The organisation of the material is frequently diffuse. For example, Chapter 4 deals with early social learning, Chapter 5 discusses the effect of language on learning and we are returned to social learning again in Chapter 6. Whilst no use is made of the material of Chapter 5 in Chapter 6 we *are* treated therein to a detour on selective attention. Such comings and goings do not help the reader develop a coherent picture of the infant either as a learner or as a developing person, and indeed much of the existing progress in our understanding of the young child is thus fragmented. This is a great pity for there is much of value in the book which trainee professionals in the social services and education might well attend to. The cumulative effects of learning are spelt out but so also is the view that deficiencies in early experience are not necessarily disastrous. The use of ' learning strategy ' is identified as a key concept and the view that the active role of the learner does not preclude a structuring role for the teacher or parent is implicit (if not entirely explicit) in much of the work. One looks forward to the two or three big books which are struggling to get out of this little book.

CHARLES DESFORGES.

PASK, G. (1975). *Conversation, Cognition and Learning: A Cybernetic Theory and Methodology.* Amsterdam: Elsevier, pp. xi+570, no price stated.

A difficult book, dauntingly technical, principally theoretical, often profound, but making some questionable empirical claims. A normative paradigm of experiment is defined in which relations (' conversations ') between experimenter and subject are governed by negotiated contract. From a ' macrotheory,' the teacher is expected to pose problems to regulate the student's subjective uncertainty. From a ' micro theory ' the student is expected to exhibit his thoughts so that the teacher can help him solve his problem. These ideas are elaborated in considerable detail.

Students, classified as 'serialists' and 'holists,' were given either a treatment *matched* (suited) to their class or a *mismatched* treatment. Pask (p. 67) concludes that the matched students learned more efficiently than the mismatched. However, the reviewer calculated from Table 3.2 that the matched students had performed significantly better than the mismatched students on a pre-test, which suggests that the end-result noted by Pask was due to initial differences in ability and not to the variation in treatment. On p. 68, Pask claims that most individuals are true to type (serialist/holist) over a variety of areas of knowledge; a mistaken reference prevents one checking this claim but the reviewer understands from the author that reports are being published in this *Journal* and elsewhere.

CASTE (a Course Assembly System and Tutorial Environment) is described. The bulk of the book is devoted to a detailed computer-inspired abstract treatment of the representation and communication of knowledge: the teacher (CASTE, etc.) is expected to engage in highly systematised and individualised conversation with the student. The teacher's and student's motivation is assumed from the initial contract between them.

Judged from the standpoint of empirical psychology of education, this book is thoroughly interesting but too sketchy in its treatment of research. The apparent coherence, breadth, and depth of theory, are impressive. The complexity of the theory, and consequently a rigorous check on the internal consistency, are beyond this reviewer's scope.

W. S. ANTHONY.

POULTON, G. A., and JAMES, T. (1975). *Pre-School Learning in the Community.* London: Routledge and Kegan Paul, pp. v+129, £3·95.

In what are now called ' deprived areas,' pre-school education is at a watershed in its development. This book, based on the experiences of the authors in the West Riding EPA, is a significant contribution to the search for alternatives that are now called for in the important pre-school sector. The ideas developed in the Red-House pre-school groups will be extremely valuable to those who see the policy of more and more nursery *schools* falling short of the needs of a community ridden with a long history of social handicap.

Overall, the book has one characteristic in common with Jensen's theory of learning. Both incorporate the notion of two levels, which as far as the book is concerned may be a function of two authors. Taking the higher level first, the book will help reorientate conventional wisdom concerning the causes of educational disadvantage. The responsibility for group differences in educational performance in the primary school must be shared by the professional educational community, the parents, and the wider society and not be seen mainly as a problem for the parent. The Plowden Report found that the main factor in educational disadvantage was home background. However, the authors' criticisms of the multivariate analysis in the report are justified. Quite apart from the the assumption of linearity, it is dangerous to conclude on the basis of a stepwise multiple regression that one ' factor ' is more important than another ' factor ' if those two factors are correlated.

As far as the lower level is concerned, the book fares badly. It is extremely irritating on two counts. Apart from the print being far too small, the book suffers from an over-condensing of the issues raised and from the absence of a clear indication of the audience for which it is intended. The book is divided into two parts, "Research and Development in Early Education " and " Pre-School and the Community." Many practitioners in the pre-school field will be put off by the academic perspective adopted in Part 1, whilst many theorists will be bored by the rather chatty style of Part 2. The first chapter (" Criteria for Success and Failure ") takes a critical look at the criteria adopted by the two main studies, Plowden and *From Birth to Seven*, in relating social background with educational performance. The general line of argument is that the current measures of educational performance such as reading tests do not take account of differences in pupils' cultural background but are biased to the so-called ' middle-class child.' This may be so, but we need further studies to show that an improvement in performance from the working-class child would result if the tests and the situations in which the tests are conducted were altered. The book fails to explain how " school achievement and adjustment . . . are a function . . . of the criteria used to measure success and failure." If the aim of the authors is to convince the educational establishment that many of its practices handicap the working-class child then they will need to produce a more convincing argument. It is all very well to say what is wrong with present and past research practice, but where are their suggestions for more suitable criteria?

Part 2 includes a survey of some recent attempts to introduce a formal element into nurseries and playgroups. The work of Marion Blank is given too much space (8 pages!) at the expense of more recent British and American efforts on this front. For example, the work of Donachy and Murphy in Scotland, the Gahagans in London and Weikart in America.

Quite rightly the authors acknowledge the significant contribution of the playgroup movement over the last decade, where there has always been a wider perspective of education than that found in the nursery school sector. Undoubtedly playgroups have much to learn from the expertise in nursery schools but nursery schools can become more effective in the community by learning from the broader aims of the playgroups.

Although the book has many faults it has many new ideas to help those who are concerned with harmonising the educational influences in the community by forging closer links between home and school. It is a book with hope and optimism which, in a time of economic retrenchment in the educational system, are qualities to be welcomed.

J. ERIC WILKINSON.

STOTT, D. H., MARSTON, N. C., and NEILL, S. J. (1975). *Taxonomy of Behaviour Disturbances.* London: University of London Press, pp. viii+184, £4·75.

This book contains essentially an updating of the Day-School edition of the Bristol Social Adjustment Guides. The authors rejected older methodology and subjective or clinical terminology, and collected from teachers descriptive data of the behaviour of 2,500 Canadian school children from 5—14 years. A sophisticated computer analysis revealed five main core behaviour syndromes, with some associated looser grouping of symptoms of behaviour disturbance. Three of the core syndromes were under-reacting behaviour—*unforthcomingness*, *withdrawal* and *depression*; the other two over-reacting —*hostility* and *inconsequence*, the authors coining the jargon-like terms ' Unract ' and ' Overact ' to refer to those groups. The old K syndrome disappeared due to contamination from hostility and inconsequence, and anxiety disappeared also as a distinct category, seeming to pervade both over and under-reacting kinds of disturbance.

Further analyses of the relationships between the core syndromes and sex, age, social class, delinquency and physical handicap were made and discussed at length. A consistently close relationship was noted between maladjustment and common health and motor handicaps (although the numbers were small) but the postulated neurological basis for both conditions " are complex and call for further study " (p. 124).

Unfortunately all these analyses are based on the assumption that a symptom count is a measure of maladjustment, which surely involves " the elementary arithmetical fault of adding quantities of unlike objects " (p. 73). Whilst realising this, the authors excuse themselves by adding only symptoms within Unract or Ovract. But surely the basic error still remains, for who can say that four withdrawn symptoms makes a child more maladjusted than two hostile ones? For this reason the results should be interpreted with care.

The newer version of the Guides, however, is very impressive, although some discussion of possible cross-cultural reasons for changes in emphasis in the types of maladjustment would have been useful. The book itself is well presented, with good statistical tables, a helpful guide to chapter contents and brief chapter summaries all adding to its clarity. Its advent should be very welcome, both to clinicians and those interested in the establishment of a more scientific and comprehensive classification of children's behaviour disturbance.

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INFORMAL OR OPEN-AREA EDUCATION IN RELATION TO ACHIEVEMENT AND PERSONALITY

BY ANNE E. BELL, MYRNA A. ZIPURSKY AND F. SWITZER
(*Child Development Clinic, Health Sciences Centre, Winnipeg, Canada*)

SUMMARY. 57 beginners in an informal or open-area programme and 112 in a traditional, formal classroom in a middle class area, apparently well-matched in perceptual, motor and cognitive skills, were followed through the primary grades. Statistical analysis of achievement data showed that the formal group from the beginning had been more proficient in reading, and later, also in mathematics. There were significant differences between matched groups (N=43) at the fourth year on seven primary CPQ factors and the second-order factor Anxiety *vs* Adjustment. Mean scores, however, with one exception (F) remained well within normal limits. Total Grade, a derived score which concerns estimation of academic success, was higher for the informal children but was predictive of achievement only for the formal group.

INTRODUCTION

THE open-area, informal or non-graded systems, was introduced in many schools as a promising solution to educational problems thought to arise out of traditional classroom or graded school programmes and practices. The flexibility and freedom associated with the informal system where the theoretical emphasis is on child-initiated learning, and a recognition of individual differences, is usually contrasted with rigidity, repression, failure and anxiety found in formal schools though this is not always true of the latter (Tewksbury, 1967). The children placed in progressive programmes theoretically are free to set their own learning pace and learn from their peers rather than from an authoritarian figure. It is assumed that all children will experience some degree of success, thus a child's feelings of self-worth will be enhanced, and his attitudes toward school and future learning will be positively oriented (Sobel and Tejirian, 1972-73). Both Packard (1972-73) and Williams (1971) have questioned the readiness and ability of many beginners to make constructive use of the freedom afforded them in the informal system. An assumption apparently made by advocates of the progressive programme is that all children come to school highly motivated and eager to learn, with appropriate patterns of social behaviour and the skills essential to effective academic achievement (Williams, 1971). In reality, a large percentage of beginners fail to fit these requirements (Bell and Aftanas, 1972; DeHirsch *et al.* 1966; Ilg and Ames, 1964; MacGinitie, 1969). Many have to be taught pre-requisite skills (Packard, 1972-73), while others require help to change undesirable attitudes toward school, teachers, and peers (Khan and Weiss, 1973; Williams, 1971).

There is some tendency to view the non-graded approach to education as contributing to the development of such traits as creativity, leadership and initiative as well as emotional and social adjustment. There is, however, considerable agreement that a child's basic personality structure has been shaped before he enters school (Khan and Weiss, 1973). Haddon and Lytton (1968) have said that since school remains only one of the many factors which impinge on the development of personality, measurable differences between schools are likely to be small. They have, however, found some evidence that divergent thinking is more characteristic of students in higher grades who have had more informal teaching in the primary school. This is a much more modest claim than those made, without research base, in what Sobel and Tejirian (1972-73, p. 563) have called the " passionate rhetoric of open classroom advocates.". While suggesting that academic achievement should be as good in informal schools as in traditional classrooms, they indicate that more studies of the effects of formal and informal teaching are required. In addition, they encourage research on affective differences due to the programmes, if objective measures are used. Goodlad and Anderson (1963) and Tewksbury (1967) have been critical of research findings on achievement in formal and informal classrooms, citing failure to distinguish clearly between non-graded and graded systems. The tendency is to equate non-grading with the absence of interior classroom walls, and a more rigid grading within the enclosed classroom. They believe that actually most schools today lie somewhere on a continuum between the poles of flexibility and rigidity.

A wide variety of objective tests are available for the measurement of school achievement; the objective measurement of personality factors is more difficult. Probably one of the best personality inventories for elementary school children is the Children's Personality Questionnaire (CPQ; Porter and Cattell, 1963). Karson (1965) has found that the CPQ discriminates successfully between boys who demonstrated acting-out behaviour and those with personality problems, and Werner (1966) reported differences between talented and under-achieving boys and girls, although this was more effective in the case of boys. Kirkendall and Ismail (1970) found evidence that personality factors were related to intellectual status. Children with high intellectual ability tended to be emotionally better-adjusted than either average or low IQ groups. Porter (1964) found basic differences between the personality patterns of gifted children and others. None of these studies, however, sheds any light on personality differences which might be observed in relation to formal and informal systems.

This paper focuses on (a) a comparison of the academic achievement of groups of children in formal and informal classrooms over the three primary grades, (*b*) the CPQ profiles of 43 pairs of these children matched for sex and IQ level during their fourth academic year, and (*c*) the relationship between second-order factors and selected measures of achievement in the two schools.

METHOD

Sample.

The children in the sample were all the beginners in two schools in the same middle-class suburb in one year. A formal school admitted 56 boys and 56 girls (N=112); while 29 boys and 28 girls entered an informal school (N=57) in Grade I classes. All the children had attended kindergarten the previous year in the same school, and would follow the curriculum as outlined by the Department of Education for the province. There were no significant age differences either between schools or between boys and girls within a school. All would be six before December 31 of their first academic year. The Blishen Index (1967), which is based on the father's occupation, showed that the two groups did not differ significantly in socioeconomic background. At the end of the third year 86 children from the sample remained in the formal school with 48 in the informal school.

Description of Schools.

The school designated as traditional classroom differed in structure from the open-area school in that each of four first-grade classes has its own enclosed classroom with its own teacher. The beginners in the informal school shared a large open space with all the 350 children in the school up to sixth-year level. Sliding walls or dividers could be closed at will, but were seldom used. Two teachers were allotted to the 57 first-year students, each with a group, similar in size to those within the classrooms in the formal school. The classes in the informal school were referred to as years rather than grades and sub-divisions within years were termed levels. In both schools reports were made in terms of levels achieved by the child during the year rather than on a pass-fail basis. The norm for first-year work in both schools was the covering of three levels of achievement, e.g., in reading, Level 1 (primers), Level 2 (first reader), Level 3 (second readers). The open-area structure was thought to facilitate the movement of students from one level of a year to a higher level within a year, or if extremely accelerated, to an early level in a higher year (grade).

The 'progressive' programme, associated with such free movement theoretically places greater emphasis on the wide range of individual differences in readiness in children of the same chronological age at school entrance. Again in theory teachers, as well as the students, should be under less pressure for achievement with concomitant anxiety. Incidental and/or self-initiated learning and the freedom of the child to set his own pace are prime concepts in the open-area, informal programme. This is not to say that teachers within a formal school are not aware of individual differences. While flexibility may indeed be facilitated to some extent by the structure of the school plant, the carrying out of the plan would seem to depend chiefly on the flexibility, ingenuity and progressive thinking of the principal and teachers within the school.

Procedure.

All of the children in their kindergarten year were tested on variables which have been found to be related to learning skills (Bell and Aftanas, 1972; DeHirsch *et al.*, 1966; Ilg and Ames, 1964). These included general intelligence, visual-motor co-ordination, visual and auditory perception, memory, linguistic, and social competency. The standard tests used were the Stanford-Binet Intelligence Scale and Vocabulary (Terman and Merrill, 1960), Bender-Gestalt, (1938), Hooper Visual-Organisation (1957), and the school readiness section of the McGahan and McGahan Early Detection Inventory (1967). The Bender-Gestalt was scored by the Koppitz (1964) method with errors deducted from the total possible (30 points) to obtain a success score which would be compatible with the ranking system of the other variables.

The auditory test had been devised by the psychological staff of the Child Development Clinic. Presented by means of a tape, it included: (*a*) memory for sentences and digits, and (*b*) consonant and vowel discrimination and sound-blending. The maximum score was 33.

The School Readiness section of the Early Detection Inventory (McGahan and McGahan, 1967) was scored numerically by giving 2, 1, or 0 to the categories designated as successful, partially correct, and unsuccessful, by the test norms, in response to questions concerning self-image, orientation, and awareness of important factual aspects of the environment.

The CPQ was administered during the fourth year to 43 pairs of children matched in sex and IQ, from the two schools. The CPQ (Porter and Cattell, 1959) which measures a set of 14 distinct dimensions of personality, allows the quantitative assessment of the various characteristics, and the comparison of individual or groups with what is expected of children of the same age on each of these dimensions. Raw scores were converted to staves to allow for the computation of two second-order factors, anxiety-adjustment and extraversion-introversion. Criterion scores for ' leadership ' and ' total grade ' were estimated.

The tests used over a period of three years to measure progress in reading and number were: Schonell Word Recognition (1961), an individually administered word list not related to the vocabulary of any specific reading series; Gates-MacGinitie Vocabulary A, B, and C, Form 1 (1965); Co-operative Primary Reading 12A, and Co-operative Primary Number Concept, 12A and 23A (1967). The latter group test is concerned with such concepts as more or less, odd or even, sequencing of numbers (16, 12, ?, 4), estimations of amount, length, etc. No computation is required. The Canadian Test of Basic Skills (1967) was administered at the end of the third year. All of the latter were group paper and pencil tests.

Attrition in the original numbers occurred yearly, while newcomers joined the research children in their classes. The achievement tests were administered to all the children in a classroom, or group, so that the research children were not singled out. As the children moved through the grades, new teachers would not necessarily know which children were being followed. The reported results, however, concern only those who had attended the same school from kindergarten to the fourth year and participated in the pre-school testing procedures.

TABLE 1

A COMPARISON OF MEAN SCORES ON PRESCHOOL TESTS OF BEGINNERS IN FORMAL AND INFORMAL CLASSROOMS.

	Formal (N=86)		Informal (N=48)	
Preschool Variables	Mean	SD	Mean	SD
Chronological Age	73·58	3·47	74·16	3·48
Mental Age	84·33	8·74	84·16	8·90
Stanford-Binet IQ	114·61	11·85	114·27	12·51
Hooper Vis. Org.	19·14	3·47	18·58	3·47
Auditory	20·65	3·62	20·12	3·41
Bender-Gestalt	25·84	2·46	25·33	2·42
Early Detection	20·05	3·38	20·60	3·32
Father's Occupation (Blishen Index)	44·23	5·03	45·21	4·93

NOTE=None of the differences between the means is significant.

RESULTS

Pre-school Battery.

Table 1 shows the mean score and standard deviation for each of the pre-school variables for the children in formal and informal schools who remained at the end of the third academic year. No significant differences in means were found between the groups on any predictor variable or on the socioeconomic index. The range of scores is comparable within the groups. Attrition in numbers over the years had not affected the original equality in mean scores or range on the predictor variables, as previously reported for the entire group of beginners (Bell, *et al.*, 1974). Since the mean IQ as beginners in both groups was within the bright normal range, a better than average academic progress might be expected as a norm.

TABLE 2

MEAN PERFORMANCE IN READING AND NUMBER IN FORMAL AND INFORMAL CLASSROOMS FROM GRADES 1 TO 3

Achievement Tests	Formal		Informal		Value
	Mean	SD	Mean	SD	
Year 1 (N=)	(112)		(57)		df=167
Sch. Word Recog.					
Midterm	5·08	3·13	3·04	2·73	4·279***
End of Term	21·25	9·72	13·96	7·10	5·012***
Gates-MacG. Vocab. A	39·85	9·66	33·26	10·94	4·007***
No. Concept 12A	35·99	8·13	37·14	7·41	0·895
Year 2 (N=)	(97)		(51)		df=146
Sch. Word Recog.	34·47	11·58	28·35	12·61	2·963**
Gates-MacG. Vocab. B	37·69	9·61	32·80	10·02	2·899**
No. Concept 23A......	33·39	7·82	33·36	6·74	0·023
Co op. Prim. Reading .	34·64	10·02	30·40	11·17	2·351*
Year 3 (N=)	(86)		(48)		df=132
Gates-MacG. Vocab. C	38·67	7·50	35·46	9·14	2·183*
CTBS (Grade Score)					
Vocabulary	4·2	·92	3·8	1·03	1·979*
Read. Comp.	4·2	1·03	4·0	1·14	0·960
No. Concepts	4·2	·94	4·2	1·14	0·203
Prob. Solving	4·5	·88	4·0	1·21	3·044**

* P< ·05 ** P< ·01 *** P< ·001

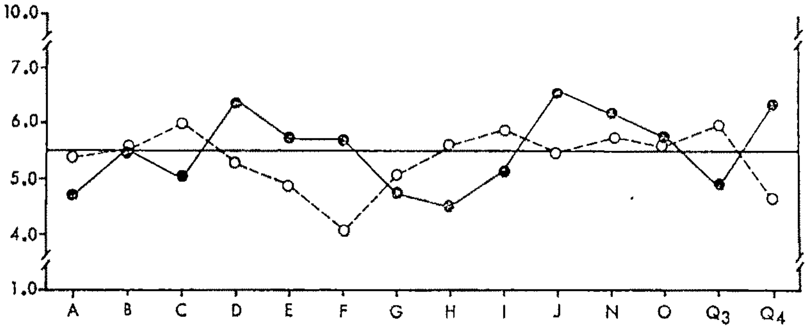
Achievement Tests.

Table 2 contrasts the mean scores of the two groups on individual and group reading tests, and number concept, over a period of three years. All the reading scores of the formal group are significantly higher than those of the informal children at the first year (P< ·001). Number Concept scores are not significantly different. Results at the end of the second year show that formal children are significantly better readers (Schonell and Gates-Mac., P< ·01; Co-op.-Prim., P< ·05). Mean scores on Number Concept are still almost identical. At the end of the third year the Gates-MacGinitie Vocabulary raw scores still favour the formal children (P< ·05). Converted to grade scores, the formal children perform at a 4·6 level; the informal children at 3·9. A grade level of 3·9 is the norm for the standardisation group at the time of year this test was given. The formal group, therefore, exceed the norm by seven months.

The differences between formal and informal children on the sub-tests of the CTBS are significant only on Vocabulary (P< ·05) and Problem Solving (P< ·01). The formal children have four months' advantage in the reading test and five months in mathematical computation. The *t* tests were performed on the raw scores, while the actual standing of the children in reference to their grade is reported in Table 2.

FIGURE 1

THE CPQ PROFILES OF 43 PAIRS OF CHILDREN MATCHED IN SEX AND IQ



Sten Scores	A	B	C	D	E	F	G	H	I	J	N	O	Q_3	Q_4
●—● TC	4.7	5.5	5.0	6.4	5.7	5.7	4.7	4.5	5.2	6.6	6.2	5.8	4.9	6.4
○--○ OA	5.4	5.5	6.0	5.3	4.9	4.1	5.1	5.6	5.9	5.5	5.8	5.6	6.0	4.7

NOTE=Factors significantly different at $P < \cdot 01$ are C, D, F, H, J, Q_3, Q_1.

Children's Personality Questionnaire.

Since CPQ scores are said to be affected by sex and IQ level, 43 matched pairs were chosen from the subjects remaining at the fourth year, on the basis of sex and IQ. The loss of five informal students is due to two factors. During the fourth year a few students were lost to the study and several informal students could not be matched with those remaining in the larger formal sample. Matching, however, was not selective but random in that it was blind on other than the selected variables. Significant differences were found on primary factors C (ego-strength), D (temperament), F (surgency), H (sociability), J (individualism), Q_3 (self-sentiment), and Q_4 (tension) (see Figure 1). The informal children were apparently more calm and mature, adventurous, thick-skinned, sober, controlled, and relaxed, liking group action, while the formal children were more emotional, enthusiastic, sensitive, individualistic and tense. In only one case, Factor F, does the mean score, however, reach beyond the average range on the profile for the CPQ (4·5 to 6·5 points). The informal children make a mean score on F of 4·1, thus showing a tendency to be sober, prudent or taciturn. This finding seems somewhat paradoxical since their normal-range scoring on factor H suggests that they are reasonably venturesome, socially bold and spontaneous. It is of interest that factor B, described as a good, brief general ability measure gives the two matched groups an identical intelligence rating as the pre-school S-B test had done four years previously with the entire group.

Second-order factors obtained in accordance with CPQ instructions (Porter and Cattell, 1959, pp. 46-48) show that the formal children are more anxious (33·86, compared with 28·51; $P < \cdot 001$) than the informal group, while no significant difference appears on the extraversion-introversion dimension (8·01 compared with 8·35). The formula for leadership success (p. 43) gives the informal children the higher rating (3·08 compared with 2·37; $P < \cdot 01$). The Total Grade estimated factor (p. 44) predicts better school achievement by the informal children (3·20 compared with 2·59, $P < \cdot 001$). As in the case of all the primary factors but one, none of these derived scores was outside of the normal range.

TABLE 3

CORRELATIONS BETWEEN CPQ TOTAL GRADE CRITERION AND ACHIEVEMENT SCORES FOR 43 PAIRS MATCHED IN SEX AND IQ

	Gates-MacG. Vocab.			CTBS	
	A	B	C	No. Concepts	Prob. Solv.
Formal.........	·319*	·335*	·307*	·313*	·362*
Informal	·193	·222	·211	·180	·179

$*P < \cdot 05$

The Total Grade predictor of achievement was significantly higher in the case of the informal children, but as Table 3 shows, Total Grade correlated significantly and consistently with achievement only in the formal school. This finding may not be unexpected since achievement in the informal school was found to be inconsistent with the abilities, and some social aspects of the children's behaviour as beginners. There were no significant correlations of achievement scores with leadership, anxiety *vs* adjustment or the extraversion *vs* introversion dimension.

DISCUSSION

The data from this study indicate clearly that primary children in a traditional classroom setting make better progress in the basic skills than children in an open-area situation. In a previous paper (Bell and Switzer, 1973) the present investigators have commented that while the research schools differed in structure, the traditional school, though graded, was committed to the concept of continuous progress rather than a rigid pass-fail system, recognising individual differences in readiness for the first-grade programme. While an absence of pressure is said to be one of the chief advantages of the informal system, remedial teachers, and parents were called upon to assist in improving the reading skills of many of the informal children after the first year. The children, therefore, were no longer being allowed complete freedom to move at their own pace.

Observations of the programmes in operation were carried on in both schools. Teachers spent time in teaching a small group in rotation while the remainder of the class were supposedly engaged in seat work. The impression gained was that the children not under close supervision in a small group in the informal classroom wasted much of their time in aimless wandering about, in watching movements of other classes, and interacting without useful purpose with their own classmates. How much incidental or self-initiated learning was actually taking place would be difficult, if not impossible, to estimate. Since both schools had well-trained, dedicated teachers, it is difficult to account for the difference in the scholastic results except in terms of the open-area structure with its many distracting influences, and the apparent need of many beginners for direction rather than permissiveness (Bell *et al.*, 1973, 1974).

Statistically significant differences are shown on a number of CPQ factors. Since, however, the mean scores on both groups lie within the normal range with one exception (F), can any functional difference in personality pattern be assumed ? Are the formal children unduly anxious or tense, or does the slightly higher anxiety score have some bearing on their better achievement? Do they perhaps try a little harder to do well? Is the statistically higher leadership score for the informal children an indication that they will be more likely than the formal children to show leadership qualities in the future? Further investigation and clarification by means of other instruments, and at a later age is indicated, and will be made since this is a longitudinal study.

The findings related to basic skills are closely similar to those reported in a recent British study (Bennett, 1976) which showed 11-year-old children in formal classrooms to have made some three to five months more progress during their final year in primary school. The impressions of classroom behaviour mentioned earlier, also tie in closely with the results of structured observations reported in the British study.

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THE ATTITUDES OF PRIMARY SCHOOL HEADS AND DEPUTY HEADS TO DEPUTY HEADSHIP

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SUMMARY. A 40-item Likert-type attitude inventory was completed by a sample of 478 primary school heads and deputy heads. The instrument consisted of items relating to attitudes to deputy headship obtained from interviews and a pilot study. A first order factor analysis yielded 10 factors, eight of which were interpreted as bureaucratic organisation, control of teaching, interpersonal relations with staff, career orientation, man-in-the-middle, collegiality, status in school, and allegiance to the head. A second order analysis indicated that the deputy head may fulfil three major functions: co-leader of the school on a par with the head, facilitating foreman, and expressive leader of teachers. Because these aspects may represent incompatible demands, it is suggested that deputy heads are especially vulnerable to role conflict.

INTRODUCTION

ALTHOUGH the structure and management of schools and the examination of the roles of senior staff have recently received increased attention, research on headship and deputy headship has been carried out mainly in the larger and more complex institutions of secondary education (Burnham, 1968; Cohen, 1970; Bernbaum, 1972; Hughes, 1972; McIntyre, 1972). Of the few investigations of the roles of primary school heads and deputies, most have been based upon small or unrepresentative samples (e.g., Caspari, 1965; Taylor, 1969; Donaldson, 1970; Belcher, 1971; Cook and Mack, 1972).

In Britain, the headteacher and his school are closely identified; the head has considerable freedom in determining the school's curriculum and organisational structure and, consequently, the roles of his subordinates. Therefore, in any school, the head's concept of deputy headship and his capacity for delegation, as well as the deputy's own ideas, play a major part in shaping the deputy head's role. This survey, by examining the conceptions of primary school heads and deputy heads, attempts to identify some of the main expectations of deputy headship.

METHOD

Construction of the Instrument.

Statements which might relate to deputy headship were gathered from previous school leadership studies, especially those of Burnham (1968) and Cohen (1970). These formed the basis of interviews about deputy headship conducted with primary school heads and deputy heads, primary education lecturers and advisers, and one of Her Majesty's Inspectors of Schools. The modified statements together with additional ones obtained from the interviews were sorted into four groups: (1) items concerned with the relationship between the deputy head and the head (2) items concerned with the relationship between the deputy head and other teachers (3) items concerned with the relationship between the deputy head and pupils and (4) items pertaining to relations between the deputy head and parents or external agencies such as the Local Education Authority and educational suppliers. Since most statements in the third group were not specific to deputy headship, but might apply equally to all primary school teachers, and because the behaviour represented by the statements in the fourth group was clearly considered by the interviewees to be principally the head's concern, most of the items in these categories were discarded; the subsequent investigation, then, focused on the deputy head's role within the school and in particular on his relations with other teachers and with the head.

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A preliminary Likert-type test, consisting of 114 statements, was given to a pilot sample of 45 heads and deputy heads. Analysis of their responses, and their comments regarding the phrasing and relevance of the items, guided the choice of variables for the inventory used in the main investigation.

The preliminary work indicated six principal areas of concern for deputy heads; these are briefly described below.

A. Interpersonal Relations Among Teachers.

Concern for the welfare of individuals and their integration into the staff as a social group. Examples of items: " Encourage a pleasant atmosphere among staff by being friendly and accessible to all," or " Look out for the personal welfare of individual teachers."

B. Instrumental or Task Emphasis.

Pertaining to the supervision of teaching and the ' output ' of the staff Examples of items: " Supervise and evaluate teacher's work," or " Encourage teachers to work up to capacity."

C. Administrative Control and Procedural Standardisation.

Concerned with the promotion and preservation of procedural norms and the suppression of individualistic behaviour by teachers: an emphasis on administrative ' tidiness ' and efficiency. Examples of items: " Apply a general school rules policy when individual teachers request special arrangements to be made for their pupils," or "Be a good organiser and administrator of staff duties and work schedules."

D. Collegiality.

Treatment of other teachers as the deputy head's peers, and acts facilitating the expression of staff opinions. Examples of items: " Encourage an equal voice in school matters to young and old teachers alike," or " Let other teachers do their work in the way they think best."

E. Mediation and Consultation.

The extent to which the deputy is an intermediary in communications between teachers and the head or acts in a consultative capacity to either teachers or the head. Examples of items: " Act as a ' go-between ' for the headteacher and teachers," or " Expect that the headteacher will seek his agreement before proposing changes in school policy or organisation."

F. School Leadership—Subordination to the Head.

The extent to which the deputy head is regarded as co-leader of the school with the head (and as a potential head himself), as opposed to being thought of mainly as a teacher, albeit a senior one, who also functions as the head's *aide*. Examples of items: " Have complete responsibility for some important aspects of school life," or " Have his own class."

The final 40-item Deputy Head Role Definition Instrument (DHRDI) contained statements relating to each of these aspects; the assignment of items to these *a priori* categories, however, was tentative and the allocation of several items was doubtful. Responses to the items were scored from 1, signifying strong agreement (absolutely must), to 5, signifying strong disagreement (absolutely must not). A test-retest reliability coefficient of 0·78 was obtained by comparing two sets of responses from 15 heads and 14 deputy heads. Abbreviated forms of the DHRDI items and the mean scores obtained from the survey are shown in Table 1.

TABLE 1

MEAN RESPONSE SCORES ON DEPUTY HEAD ROLE DEFINITION INSTRUMENT
(Heads and Deputy Heads N=478)

Item No.	Abbreviated form of item	Mean
1	Look out for personal welfare of individual teachers	1·72
2	Persuade teachers to try new methods	2·07
3	Put welfare of staff above that of individual teachers	1·55
4	Discourage 'outlandish' classroom methods	2·92
5	Help staff with personal teaching problems	1·58
6	Ensure recognition for jobs well done	1·56
7	Apply general school rules policy	2·54
8	Encourage equality between young and old teachers	1·72
9	Co-ordinate departments or year groups	1·95
10	Be friendly and accessible to all	1·10
11	Supervise and evaluate teachers' work	3·29
12	Secure teachers' approval on school matters	2·05
13	Allow individuality in teaching methods	2·34
14	Ask teachers to follow standard routines	1·51
15	Keep teachers informed about policy and changes	1·13
16	Inform teachers of expected standards	2·10
17	Put teachers' suggestions into operation	2·83
18	Keep informed of staff opinions on school issues	1·39
19	Reprimand teachers who don't conform to agreed procedures	3·49
20	Encourage teachers to work up to capacity	1·83
21	Be a good organiser of staff duties and schedules	1·30
22	Put over own ideas about teaching and organisation	1·97
23	Attend to welfare of children throughout school	1·89
24	Make own attitudes clear to staff	1·59
25	Emphasise the meeting of deadlines	1·71
26	Expect head to seek his agreement before proposing changes	1·68
27	Relay teachers' suggestion to the head	1·36
28	Have complete responsibility for some aspects of school life	1·62
29	Allow loyalty to head to precede loyalty to staff	2·19
30	Relay head's decisions and instructions to staff	1·56
31	Question head's decisions if these considered unwise	1·70
32	Have duties separate from those of the head	2·02
33	Expect head to make final decisions in all school matters	1·23
34	Have his own class	2·73
35	Act as a ' go-between ' for head and teachers	1·79
36	Be a good classroom teacher	1·22
37	Have had varied teaching experience in other schools	1·78
38	Regard the post as a preparation for headship	2·20
39	Have his own room other than a classroom	2·16
40	Put head's point of view when staff are critical of policies	1·43

Sample.

Subjects were the heads and deputy heads of 340 primary schools (pupils aged 5-11) randomly selected from the schools lists of nine English local education authorities. Schools with fewer than 100 pupils, however, were not included since at the time the data were collected these were not obliged to have an officially designated deputy head. Completed documents suitable for analysis were eventually returned by 232 heads and 246 deputy heads (70·3 per cent of the sample).

Factor Analytic Procedure.

Since this was an exploratory survey in an area hitherto handled largely by intuition, factor analysis appeared to be the most suitable technique to apply in order to clarify the dimensions of deputy headship. The principal components factorial method was employed and 10 components with latent roots greater than unity were extracted; these were rotated to the Promax criterion of oblique simple structure (Hendrickson and White, 1964). Loadings of ±0·3 and over were considered in interpreting the factors (Child, 1970).

RESULTS

First Order Factor Analysis.

The 10 factors extracted and rotated accounted for 48·9 per cent of the total variance. Table 2 shows the loadings of the items on each factor.

TABLE 2

DEPUTY HEAD ROLE DEFINITION INSTRUMENT.
LOADINGS ON TEN PROMAX FACTORS.

Item No.	*A priori* Group	Factors									
		I	II	III	IV	V	VI	VII	VIII	IX	X
1	A				−31			30			
2	B		55				32				
3	C	70									
4	B		65								
5	A			34							
6	D					31					
7	C	50						−35			
8	D						65				
9	D		45				39				
10	A			75							
11	B		73								
12	D						49				45
13	D		−48				36				
14	C	46									
15	A						34				
16	B		61								
17	D										64
18	A			55				32			
19	C		71								
20	B		39					43			
21	C			59							
22	B				36					—38	
23	F							75			
24	D							71			
25	C	43									
26	E										68
27	E					68					
28	F										
29	F	56								30	
30	E					65					
31	F									—61	
32	C	48									
33	F									68	
34	F								−73		
35	E					80		−32			
36	B				60						
37	F				68						
38	F				61						
39	F								76		
40	E					44					
% variance accounted for		5·1	8·1	4·6	4·9	5·8	4·1	5·1	3·8	3·5	3·8

Decimal points omitted. Loadings less than ±0·3 omitted.

The items with the highest loadings on Factor I come from *a priori* Group C, and an emphasis on the specification and observation of standardised procedures is apparent; this is, therefore, identified as a factor of *Bureaucratic Organisation*. Most of the items with high loadings on Factor II are from Group B and pertain to the definition of teaching roles and the supervision of instruction; the items from other groups fit in well with this general pattern and the significant negative loading on Item 13 confirms the interpretation of this factor as *Control of Teaching*. It is sometimes suggested that one of the deputy head's main functions in the school is to ' oil the works '; Factor III may pertain to this facilitating function: by including Item 21 along with the items from Group A it associates social agreeableness and consideration for colleagues with administrative efficiency. This factor is identified as one of *Interpersonal Relations* with teachers. Factor IV associates a group of items relating to the deputy's experience and his attitudes to teaching and promotion; the negative loading on the item from Group A (Item 1) suggests that the adoption of a forceful, instrumental attitude to deputy headship may conflict with the interpersonal dimension indicated in Factor III. The fourth factor is identified as one of *Career Orientation*. Factor V brings together items depicting the deputy head's position as an intermediary in communication between the head and teachers; it is a *Man-in-the-Middle* or *Janus* factor. Factor VI picks out the items from Group D which portray the deputy head as a colleague of other teachers, providing them with information and co-ordinating their work but encouraging the expression of their views and respecting their autonomy. The item from Group A (Item 15) is also in keeping with the interpretation of this factor as one of *Collegiality*.

Factors VII and X are difficult to interpret; Factors VIII and IX, however though small, are of interest in that both are bi-polar and may point to specific dilemmas facing the deputy head. Factor VIII indicates a potential conflict between the deputy's role in the school as a whole and his role as a class teacher; it pertains to the deputy head's *Status in the School*. Factor IX is concerned with the deputy head's subordination to or parity with the head; it appears to be a factor of *Allegiance* to the head.

For the most part, the first order factors reflected the groups originally formulated, but with some important refinements: in particular, the emergence of the *Career Orientation* factor and the sharpened distinction between control of teaching and administrative or bureaucratic control. Promax, of course, rotates factors into optimum simple structure regardless of orthogonality; nevertheless, the correlations between the first order factors seemed to make good sense: *Bureaucratic Organisation* correlated 0·32 with *Man-in-the-Middle*, for example, and *Interpersonal Relations* correlated —0·30 with *Control of Teaching*. It seemed, then, that attitudes to deputy headship might be expressed in terms of a smaller number of dimensions, and the analysis was carried to the second order level by factorising the correlations shown in Table 3.

Second Order Factor Analysis.

Four principal components with latent roots greater than 1·0 were obtained and rotated to the Varimax orthogonal criterion (Kaiser, 1958); these together accounted for a very substantial proportion of the total variance represented by the 10 initial factors (57·3 per cent). Interpretation was as follows:

TABLE 3

MATRIX OF CORRELATIONS AMONG TEN PROMAX FACTORS.

	I	II	III	IV	V	VI	VII	VIII	IX	X
I	—									
II	−16	—								
III	09	−30	—							
IV	−22	14	03	—						
V	32	−17	21	−13	—					
VI	02	01	01	03	−13	—				
VII	30	−21	13	−14	34	−24	—			
VIII	02	05	−25	−07	−03	−09	18	—		
IX	−10	14	02	13	−15	01	−18	−17	—	
X	01	04	10	−01	−02	−02	16	13	02	—

Decimal points omitted.

Second Order Factor I (16·6 *per cent of variance*).

This associates a strong dimension of independent, ‘head-like’ career items (“ Have own ideas which he should want to put over”; “Regard post as preparation for headship ”) with alignment with and support of the head (“ Loyalty to head to take precedence over loyalty to teachers”; “ Put head’s point of view when teachers critical”). This appears to represent a joint leadership view of the head-deputy head partnership and is identified as *Quasi Headship.*

Second Order Factor II (15·6 *per cent variance*).

This is loaded by items relating to administrative clarity and routine (“Be a good organiser and administrator”; “Ask that teachers follow standard routines ”) and considerate interpersonal relations between the deputy and teachers (“ Know staff well enough to help with personal problems”; “ Encourage pleasant atmosphere”). Communication is predominantly downward and the factor seems to be concerned with the deputy head’s part in keeping the school running smoothly and at the same time encouraging and helping the teachers to give of their best efforts (perhaps two sides of the same thing). The factor represents the deputy head as a considerate foreman and is tentatively identified as a *Facilitation* dimension.

Second Order Factor III (13·7 *per cent of variance*).

This gathers together the collegial items and the acts on behalf of teachers (“ Keep teachers informed”; “ Encourage an equal voice to young and old”; “ Let teachers work in the way they think best ”) and is identified as *Expressive Leadership.*

Second Order Factor IV (11·4 *per cent of variance*).

Significant positive loadings on instrumental items in which the opinions of teachers or the deputy head are taken into account before changes are made (“ Expect that head will seek agreement before proposing changes”; “ Put teachers’ suggestions into operation ”), and a significant negative loading on “ Ask that teachers follow standard routines ” suggest that this factor may have to do with professional *versus* bureaucratic forms of organisation. It is tentatively called *Professionalism.*

TABLE 4

ITEM LOADINGS ON SECOND ORDER FACTORS.

Item	Factors			
	I	II	III	IV
1		45		
2			31	
4	32	33		
5		44	36	
6	30		44	
7	33			
8			46	
9			37	
10		33		
12			38	40
13			41	
14		45		−31
15			51	
16		44		
17				48
18		35	36	
20		45		
21		55		
22	61			
24	38		42	
25	52			
26				61
27			33	
28	55			
92	37			
30		30		
31	41			
36	30			
37	37			
38	39			
39	32			30
40	31			
% variance accounted for	16·6	15·6	13·7	11·4

Decimal points omitted. Loadings less than ±0·3 omitted.

Separate factor analyses of the responses of heads and deputy heads produced similar factors to the analysis of the two groups together. Moreover, in the larger project of which the factor analytic study reported here forms a part, the responses of heads and deputy heads to each item were compared by analysis of variance. The difference between the two groups was significant at the 0·01 level or higher on only two items (6 and 15); in both cases the behaviour indicated was more strongly supported by the deputies than by the heads.

DISCUSSION

Many researchers (Gibb, 1969) have suggested that there are two major aspects to leadership: person-centred and task-centred. Drawing on this dichotomy, Burnham (1968) proposed the sharing of leadership functions between the head and the deputy in the secondary school, the head being the instrumental or task leader and the deputy being the expressive or social-emotional leader of the staff. The item scores in the present study indicate some support for a social-emotional leadership rationale for primary school deputy headship rather than an instrumental one: the behaviours in First Order Factors III and VI (Interpersonal Relations and Collegiality) were generally supported as appropriate for deputy heads, but those in First Order Factor II (Control of Teaching) were weakly supported or rejected. The second order analysis brought out more clearly an expressive leadership dimension.

In primary schools, decision-making tends to be zoned: whereas teachers are comparatively indifferent to administrative matters relating to the school as a whole and they accept executive dominance in this zone, they expect freedom from interference in their teaching and a high degree of discretion within the classroom (Lortie, 1969). Nevertheless, with regard to the supervision and evaluation of other teachers, there is less to constrain the head than the deputy because authority in the primary school is firmly concentrated in the head's hands and school articles of government normally hold him responsible for the curriculum and teaching. Thus, since the deputy's part in directing and controlling the central (teaching) tasks of the school is rather uncertain, his main instrumental function resembles that of a foreman: he mediates communication between the head and teachers, monitors the observance of norms and procedures, and helps teachers to carry out their duties.

Although the heads in the sample were for the most part in agreement with the deputy heads about the behaviours appropriate to deputy headship, important differences of opinion between the two groups were found when respondents were asked if they considered the behaviours described in the first 25 questionnaire items *more* appropriate to the head or the deputy head. These differences are detailed elsewhere (Coulson, 1976), but the main points are pertinent to the present discussion. The heads and the deputy heads were agreed that instrumental matters, such as the control of teaching, are mainly the head's concern; to a lesser extent they also agreed that administrative functions, such as the dissemination of information to teachers and the organisation of duties, are more appropriate to the deputy head. With regard to the social-emotional leadership of teachers, however, their views differed considerably: whereas the deputies considered that this is more their concern, the heads saw the management of issues connected with the welfare of teachers and the social climate of the staffroom as an integral part of their own overall supervisory function. Considered in conjunction with the factor analysis reported in the present paper, these findings suggest that though the deputy head is expected to make a major contribution to the smooth running of the school, heads typically take an all-encompassing view of their own leadership which may leave the deputy little room to develop a distinct role of his own.

The deputy head's previous career has probably provided little preparation for undertaking his present job's principal functions—administration and the social-emotional leadership of colleagues; moreover, he is very vulnerable to role conflict because he occupies a position which may be ambiguously defined *vis-a-vis* that of the head and subject to cross pressures from the head and teachers. Furthermore, it appears that although most deputy heads have had long, and presumably successful, teaching experience, curricular and teaching matters in the school as a whole are not to the forefront among the deputy's responsibilities. It may be, therefore, that a desire to gain greater freedom and influence in this most crucial area of school life, allied to lack of satisfaction in their present role, motivates many deputy heads to seek further promotion.

The deputy who regards his present post as a stepping stone to a headship may be faced with a dilemma: to what extent should he focus on the present and accept a servicing role mainly orientated to supporting colleagues and implementing measures initiated by others (Second Order Factors II and III), and to what extent should he focus on the future and adopt a more independent, instrumental stance in preparation for headship (Second Order Factor I)?

Although nominally different status levels have now been established, primary school personnel tend to be regarded in an undifferentiated way simply as 'teachers'. As educational institutions become more complex in structure, however, there is an increasing need to consider carefully the functions which different positions perform in the context both of the organisation of the school and of the career of the individual.

This study was based on the conceptions of primary school heads and deputy heads and represents one tentative approach to research on the roles of teachers at different status levels in schools. There is a need for the development of more refined survey methods and for the investigation of actual behaviour in schools as well as of teachers' role conceptions.

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LEVELS OF CONCEPT ACQUISITION AND CONCEPT MATURATION IN STUDENTS OF CHEMISTRY

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SUMMARY. Levels of concept acquisition in terms of attribute perception were examined for 20 different chemical concepts featuring in GCE O-level school chemistry courses. The instrument used was a 'concept perception' test describing concept attributes in a hierarchical sequence ranging from a specific, concrete level to a generalised abstract level. This test was administered to 560 14 to 16-year-old secondary school pupils. Findings indicate that levels of concept acquisition change significantly from the concrete to the abstract description with the advancement of students from the third to the fifth form level, but the absolute level of the association of concept labels with their abstract interpretation is generally low even at the highest educational level examined. The adjustment from concrete to abstract attributes of chemical concepts appears strongly dependent on the length of concept maturation periods, but is not influenced by students' IQ levels.

INTRODUCTION

THE normal teaching route leading to the development of scientific concepts in school science courses proceeds along the following sequence of phases:

(i) Initially, the student is introduced to a specific exemplar of a concept.

(ii) Thereafter, he is exposed to further exemplars of the concept. From this, the notion of a class identity is established, but on the basis of a limited range of attributes (for example, by reference to some characteristic property or test).

(iii) In the third phase, the concept is operationally defined by means of a statement which seeks to include all exemplars of the concept in terms of generally valid attributes which relate directly to the student's ' concrete ' experience.

(iv) Finally, the class identity of the concept is described in terms of atomic or molecular phenomena, i.e., attributes which are ' abstract ' in character.

The progression along this sequence requires the learner to modify continuously his own perception of a concept by accepting and utilising an increasingly higher degree of abstraction as it relates to alternative sets of 'defining' attributes of the concept. For example, the concept of ' acid ', initially introduced through the attributes of sourness and colour changes in relation to certain indicators, is gradually transformed into one characterised by the ' replaceability of hydrogen by metals.' This definition is an operational one and, since it refers to a directly perceivable phenomenon, may be classified as ' concrete.' The characterisation of an acid as a proton-donor utilises a property which evades direct perception and has to be inferred through mental operations: the defining attribute is now an ' abstract ' one.

As the learner progresses along the concrete/abstract dimension as identified by phases (i) to (iv), he is required to adjust at each stage to a new set of concept attributes. The adjustment is unlikely to be instantaneous upon the student's encounter of the new concept description. Instead, it may be hypothesised that a maturation period is required during which the student's perception of a concept changes from attributes previously encountered to its new description. It is not unreasonable to assume that even if a student has learned and understood the new attributes of a concept, he continues to associate in his own independent thinking the concept label with the defining attributes previously learned.

Several factors may be thought of as influencing the rate at which the learner adjusts from one set of concept attributes to a new one. One is the degree of reinforcement provided by the instruction in the use of the new defining attributes; another may be the intrinsic difficulty of a new concept description, especially if this relates to the ' abstract ' characteristics of a concept. Whatever influence these factors may have, they would merely modify the length of the concept maturation process, without eliminating it altogether.

Of particular interest is the adjustment of students from the highest ' concrete ' description of a concept to its ' abstract ' characterisation. This is so because many problem-solving situations occurring in O-level chemistry teaching at the fourth and fifth-form level require concepts to be used in their ' abstract ' form. Unless a student's perception of concepts is firmly linked to their abstract attributes, he is unlikely to be able to attend satisfactorily to such problem-solving tasks unless the format of task definition does, in itself, provide adequate cueing to the nature of the attributes to be selected and employed. So-called ' immature ' attempts of problem-solving, well known to every teacher of chemistry, may thus be the result not of an inadequate ability of the student, but arise from his failure to adjust to the type of concept attributes which are essential for the solution of the problem.

The purpose of this study was to examine levels of concept acquisition along the concrete/abstract dimension described above, and of concept maturation in relation to selected chemical concept presented in the context of GCE (Ordinary Level) courses. Altogether 20 concepts were examined which, in their simplest formulation, are normally introduced during the first two years of a five-year O-level school chemistry programme. The perception of these concepts by students at the third form, fourth form and fifth form level was investigated and resulting patterns compared.

It was hypothesised that students' perception of the concepts would tend progressively more towards the abstract end of the concrete/abstract dimension as characterised by the sequence from phase (i) to phase (iv), with increasing educational level. Also, it was thought likely that the extent to which at the fifth form level students associated concepts with their ' abstract ' attributes would be affected (*a*) by the length of time which had elapsed since their introduction to the conceptualised description of the concepts (as a measure of concept maturation periods), and (*b*) by students' general intelligence. All these aspects were examined.

METHOD

The ' concept perception ' test.

The rationale underlying the design of the test was that each item should confront students with a particular concept label as stimulus to which they responded by selecting from a number of alternative statements the one that corresponded most closely to their perception of the concept. For each concept, four responses were constructed exemplifying the following categories:

I. Specificity—expressed by a statement in terms of a specific example, usually representing the simplest of most common exemplar of the concept.

II. GENERALITY—presented in the form of a statement involving a quality of property whereby several exemplars of a concept may be identified.

III. OPERATIONAL DEFINITION—a statement which seeks to include all exemplars of a concept but is couched in terms of attributes which relate to direct experience.

IV. CONCEPTUAL DEFINITION—a statement similar to an operational definition but held in terms of attributes relating to the atomic or molecular basis of the concept.

The following responses, relating to the concept ' acid,' illustrate the above categories.

(*a*) An acid is a substance like sulphuric acid. It is dangerous and can easily cause burns.
(*b*) An acid is a substance which will turn blue litmus red and have a recognisable effect on other indicators.
(*c*) An acid is a substance which contains hydrogen which may be replaced by metals.
(*d*) An acid is a substance which can donate protons to another substance.

All these responses are essentially correct, but each reflects a different point along the concrete/abstract dimension discussed above.

The construct validity of the 20-item ' concept perception ' test was assessed by a panel of judges each of whom had had at least 10 years' teaching experience. The validation exercise confirmed the construct validity of over 90 per cent of the responses. The remaining responses were modified so as to conform with the response specifications.

Independently, chemistry teachers in the schools participating in the study were asked to identify the approximate time in their five-year O-level chemistry course at which students would normally be expected to be familiar with concept descriptions at the different levels. This confirmed for each concept represented in the test, the hierarchical nature of the response sequence from ' specificity ' to ' conceptual definition.'

In completing the test, students were asked to select from the four responses associated with each concept label the one that most closely agreed with their idea of the meaning of the concept. They were also given the opportunity of either indicating, where appropriate, their non-familiarity with a particular concept or, if the given responses were deemed to be unsatisfactory, to present their own version of the concept. It was found that, where the latter has been done, the alternative responses could invariably be linked to one of the responses given in the test.

The 'concept perception' test was designed as a diagnostic tool and treated as such in the evaluation of data from it. Therefore, the analysis of the test with a view to establishing the usual test statistics was deemed inappropriate.

Samples.

The study involved approximately 560 pupils at third form, fourth form and fifth form level, respectively, drawn from eight schools in the Leeds/York area.

All students were following O-level chemistry courses based on the current syllabus of the Joint Matriculation Board (JMB, 1973). The distribution of students by sex and educational levels is shown in Table 1.

TABLE 1

RESPONSE DISTRIBUTIONS (PERCENTAGES) FOR DIFFERENT CONCEPTS AND AGE LEVELS
N= Third Formers: 136 boys, 80 girls; Fourth Formers: 128 boys, 64 girls;
Fifth Formers: 98 boys, 56 girls.

Concept	Form	Response Level					Significance Level P<
		0	I	II	III	IV	
1. Gas	3	—	15	24	36	25	0·001
	4	—	10	7	51	32	NS
	5	—	4	4	51	41	
2. Electrolysis	3	12	4	12	38	34	0·001
	4	—	2	6	42	50	NS
	5	—	—	5	35	60	
3. Atom	3	1	3	20	43	33	0·001
	4	—	3	12	32	53	NS
	5	—	—	13	35	52	
4. Metal	3	2	27	43	19	9	0·001
	4	—	14	35	26	25	0·01
	5	—	6	23	37	34	
5. Element	3	1	21	15	42	21	NS
	4	—	18	14	49	19	0·001
	5	—	6	6	55	33	
6. Acid	3	—	48	45	5	2	0·001
	4	—	21	42	26	11	0·001
	5	—	7	38	32	23	
7. Alkali	3	1	13	69	11	6	0·001
	4	—	9	47	38	6	0·02
	5	—	7	42	34	17	
8. Reduction	3	14	28	24	33	1	0·001
	4	—	29	11	49	11	0·001
	5	—	9	7	52	32	
9. Electrical Conductor	3	1	16	17	58	8	0·01
	4	—	9	17	57	17	NS
	5	—	8	13	52	27	
10. Pure Substance	3	4	26	55	8	7	0·001
	4	—	20	49	18	13	NS
	5	—	10	50	24	16	

Concept	Form	Response Level					Significance Level P<
		0	I	II	III	IV	
11. Melting	3	—	14	10	60	16	0·001
	4	—	4	3	60	33	NS
	5	—	3	4	63	30	
12. Indicator	3	—	11	44	34	11	0·001
	4	—	6	22	53	19	NS
	5	—	3	23	57	17	
13. Crystallisation	3	2	29	38	20	11	0·001
	4	—	12	47	18	23	NS
	5	—	12	46	18	24	
14. Ion	3	29	2	10	41	18	0·001
	4	4	4	9	67	16	0·05
	5	—	4	14	57	25	
15. Mixture	3	—	34	14	48	4	0·001
	4	—	18	11	65	6	0·05
	5	—	11	11	64	14	
16. Solution	3	—	35	29	21	15	NS
	4	—	32	28	28	12	NS
	5	—	28	40	20	12	
17. Energy	3	—	7	37	41	15	0·001
	4	—	3	22	64	11	NS
	5	—	2	17	61	20	
18. Compound	3	—	3	28	61	8	0·001
	4	—	—	14	80	6	NS
	5	—	—	12	82	6	
19. Salt	3	—	55	27	12	6	0·001
	4	—	30	44	23	3	0·01
	5	—	15	45	34	6	
20. Catalyst	3	39	1	31	20	9	0·001
	4	6	2	24	63	5	0·001
	5	—	—	12	80	8	

Response level 0 indicates non-familiarity with the particular concept.
In the evaluation of significance levels, response categories 0 and I were combined.

Procedure.

The administration of the concept perception test was conducted half-way through the academic year, and was followed within a week by the administration of the AH4 test (Heim, 1970) as a measure of students' general ability.

RESULTS AND DISCUSSION

Table I summarises the percentage distribution of responses for the different concepts included in the concept perception test, in relation to students' educational levels as indicated by their school forms. Response categories I to IV correspond to the four construct criteria identified in the preceding section. Response category 0 represents non-familiarity with a concept.

Significance levels quoted in Table 1 were derived from χ^2 calculations comparing the response profiles of third and fourth year students, and of fourth and fifth year students, respectively. For the purpose of these comparisons, the assumption was made that the sample populations representing the three educational levels were basically equivalent and differed only with respect to their age and the corresponding advancement in a fixed curriculum.

Qualitatively, the data indicate that for most concepts the response preference shifts towards the abstract end of the concrete/abstract dimension as students progress from the third form level to the fifth form level. This progression appears in two forms, which are often combined: the distinct increase in the percentage of students opting for Category IV response or, if the latter is not pronounced, a definite adjustment from categories I and II to category III responses. These trends confirm the hierarchical nature of the four phases of concept acquisition identified.

When the significance of these progressions is examined, it is seen that a steady shift in the response patterns to the abstract end occurs for only a few concepts. In most other cases the change in response profile from the fourth to the fifth form level is insignificant, although there is generally a major advancement from the third form to the fourth form level. For these concepts, the association between a concept label and its perceived meaning appears to stabilise at the fourth form level and remains largely unaffected by students' subsequent experience in chemistry.

Why this premature stabilisation of response patterns should occur is difficult to analyse on an *ex post facto* basis. It is certainly true that some of the concepts found to stabilise at the fourth form level play a relatively minor role in the teaching of chemistry in the fourth form and fifth form. This would apply to concepts such as *pure substance*, *mixture*, *compound*, *melting* and *crystallisation*. Although students are invariably introduced to the abstract definitions of these concepts, little reinforcement of them is provided, thus resulting in perception profiles in which the preference for concrete attributes predominates. Other concepts, e.g., *gas*, *atom*, *electrolysis*, are stressed early on in a chemistry programme in their conceptualised version, and it is these which are subsequently reinforced to a considerable extent. This would explain the high category IV preferences shown in these cases.

Even at the fifth-form level, as the highest educational level covered in the investigation, the extent to which students associate concept labels with their conceptualised, abstract interpretation is generally remarkably low. Averaged over all concepts, only about 25 per cent of the students selected category IV responses, although there are major differences between individual concepts. It was thought possible that the extent to which for particular concepts category IV responses were preferred would be related to the concept 'maturation period,' defined as the time interval between the point of testing (six months into the fifth form) and the time at which students had been introduced to the abstract interpretation of a concept. To examine this, the correlation between the percentage of category IV responses and the length of the maturation phase was analysed, using the data in Table 2. Spearman's ρ was found to be 0·58 and is significant at the one per cent level (Siegel, 1956). In other words: the extent to which students adjust to the abstract interpretations of concepts follows broadly the order in which they become acquainted with them. This finding gives basic support to the 'maturation' argument outlined above, notwithstanding the influence on it by instructional conditions and, possibly, the intrinsic difficulty of new attribute sets.

TABLE 2

THE EFFECT ON CONCEPT MATURATION TIME ON FIFTH FORMERS' PREFERENCE FOR CATEGORY IV RESPONSES.

Concept	Level at which Familiarity with Category IV Response is expected by Teachers		Sequence of Expected Category IV Familiarity (Rank Order)	Percentage of Category IV Responses at Fifth-Form Level	Rank Order of Concepts in Terms of Category IV Preferences
	(Form)	(Month)			
Electrolysis	3	2	1	60	1
Compound	3	5	2	6	17
Element	3	6	3	33	5
Atom	3	7	4	52	2
Gas	3	9	5	41	3
Energy	4	0	6	20	11
Mixture	4	1	7	14	14
Pure Substance	4	1	7	16	13
Metal	4	2	8	34	4
Ion	4	3	9	25	9
Salt	4	4	10	6	17
Solution	4	5	11	12	15
Melting	4	6	12	30	7
Elect. Conductor	4	6	12	27	8
Reduction	4	7	13	32	6
Acid	4	8	14	23	10
Alkali	4	8	14	17	12
Indicator	4	8	14	17	12
Crystallisation	5	0	15	17	12
Catalyst	5	2	16	8	16

Spearman Rank Order Correlation Coefficient, $\rho=0{\cdot}58$ ($P<0{\cdot}01$)

When teachers were asked to indicate the response preferences which they expected their fifth form students to show in relation to the various concepts examined, the general assumption was that category IV responses would generally be chosen. The summary results in Table 2 show this assumption to be incorrect. Admittedly, since the present study involved only eight fifth form sets and seven teachers, it is difficult to generalise on the basis of limited evidence. However, the strong indication is that teachers tend to over-estimate the rate and extent to which their students adjust from one form of concept description to the next one.

One likely consequence of students' extensive preference for the concrete characterisation of concepts is that they may encounter difficulties when attending to problem-solving situations requiring concepts to be applied in their abstract version. Even if students are capable of handling intellectually the abstract attributes associated with a particular concept, it would still be improbable that they would apply them in the solution of a problem as long as their own perception of the concept is firmly fixed on its concrete attributes. This, of course, would apply only in situations where insufficient cueing is provided to the use of particular attribute sets; but many of these situations arise frequently in the context of school chemistry courses. Failure on the student's part to solve a problem adequately may then not lie in his inability as such, but stem entirely from his 'wrong' perception of concepts required for the solution.

The sample populations embraced both boys and girls, and so an examination of the influence of sex on the response distribution patterns was made. This showed no significant differences between the sexes to exist. A similar analysis, comparing the populations drawn from different schools, also revealed no significant differences, other than those relating to the perception of concepts at different educational levels.

In order to study the effect of IQ on the perception of the concepts, a comparison was made of the response patterns measured for low and high IQ students in each of the three educational years. The two IQ groups were defined by the following score ranges on the AH4 test, corresponding approximately to the top and bottom quartiles, respectively, of the populations in each year:

Low IQ groups: AH4 score $\leqslant 80$
High IQ groups: AH4 score $\geqslant 100$

The data relating to this analysis are given in Table 3, but here the response distributions represent averages covering all concepts examined.

TABLE 3

THE EFFECT OF GENERAL ABILITY (IQ) ON RESPONSE PREFERENCES.

Form	IQ Level	Response Distribution (percentised) for Levels				χ^2 Value and Significance Level
		0+I	II	III	IV	
Third	High	13	31	39	17	1·96
	Low	25	32	30	13	NS
Fourth	High	8	21	50	21	1·64
	Low	15	27	42	16	NS
Fifth	High	5	20	51	24	0·44
	Low	8	23	43	26	NS

At the fifth form level, an extensive concordance of the response profiles for the two IQ groups is noted. For the fourth-form and third-form students, some qualitative differentiation between high IQ and low IQ pupils appears, with the former generally tending to the higher end of the concrete/abstract domain. However, no adequate statistical significance can be attributed to these differences which must therefore be considered very cautiously.

The absence of a clear differentiation between high and low IQ students in the concept perception test is somewhat surprising. It might reasonably have been assumed that a perception preference for the abstract attributes of a concept would be closely related to students' actual formal reasoning abilities as identified by Piaget and Inhelder (1959). Since the latter have been shown to be strongly IQ dependent (Mealings, 1963), a similar dependence might have been expected for the perception of concepts attributes along the concrete/abstract dimension. This, judging from the present data, does not appear to be the case, and further studies are in progress to elucidate this issue.

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PREDICTION OF FAILURE AT UNIVERSITY—OR FAILURE OF PREDICTION ?

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SUMMARY. The validity of a procedure for identifying students at risk of failure on the basis of first term examination results was checked by following up 188 students at risk, from a total of 1902 in Aberdeen University Arts Faculty in session 1974-5. 76 per cent of the students at risk recovered successfully, and 40 per cent of failing students were missed by the procedure. Comparison of students who fail and those who recover, and of failing students identified as at risk and those not identified, and other attempts to find a means of improving the early warning system, were unproductive. The value of the system may lie not in prediction but in demonstrating awareness and concern.

INTRODUCTION

THE main aim of the early warning system which has operated in the University of Aberdeen since 1963 is the early identification of students at risk of failure. On the whole the system has worked well, but still too many students who are unsuccessful at university manage to slip through the early warning net, and conversely many who are identified as being ' at risk ' go on to successful completion of their studies.

At the beginning of session 1974-75, the Faculty of Arts asked the Department of Education in co-operation with Faculty advisers of studies to examine the system in order to find out if there were any ways of improving it. One criticism of the system was that prediction of failure was based almost entirely on performance in first term class examinations. Little attempt was made to build up a comprehensive picture of the student 'at risk,' and to ascertain if any characteristics or groups of characteristics associated with failure emerged. Were ' at risk ' students who subsequently pass any different from those who subsequently fail? Could the criterion of poor class examination performance be replaced or supplemented by some more valid predictor of failure ?

METHOD

In January 1975, the standard early warning procedure was operated and advisers were notified of their students who were ' at risk of failure.' The criterion for ' at risk ' was a mark in the bottom third of the class in the first term examinations in at least one subject, depending on year of study. In March, 1975, all advisers (with the exception of one adviser to four ' at risk ' students who was abroad at the time) were interviewed. Between the drawing up of ' at risk ' lists and the interviews of advisers, several ' at risk ' students withdrew from university. Excluding these, the final total of students about whom advisers were interviewed was 188: 109 in first year, 61 in second, 11 in third, and 7 in fourth year.

RESULTS

In October, 1975, 87 students with unsatisfactory degree examination records were reported to the Committee Anent Students. Table 1 shows the outcome of decisions made by the committee affecting these 87 students. The majority were declared unsatisfactory and required to terminate studies. Of these, 60 per cent (45 out of 75) had been identified by the early warning system as being ' at risk of failure ' (Table 2). On the other hand, these 45 ' at risk ' unsatisfactory students represent only 24 per cent (45 out of 188) of the total number of students ' at risk ' after Christmas.

TABLE 1

NUMBERS REPORTED TO COMMITTEE ANENT STUDENTS IN OCTOBER 1975, AND OUTCOME.

Year	Reported to Committee	Unsatisfactory discontinued	Unsatisfactory continuing	'No order'
1	53	47*	5	1
2	28	24	3	1
3/4	6	4	1	1
Total	87	75**	9	3

*47 is 8 per cent of 556, the total number of 1st year undergraduates in Arts.
**75 is 7 per cent of 1902, the total number of undergraduates in all years in Arts.

TABLE 2

'AT RISK' STUDENTS REPORTED TO ADVISERS IN JANUARY 1975, AND OUTCOME OF SESSION FOR THEM.

Year	Reported to advisers	Unsatisfactory discontinued	Unsatisfactory continuing	'No order'
1	109	31	2	1
2	61	12	1	0
3/4	18	2	1	0
Total	188	45	4	1

Two conclusions can therefore be drawn from Tables 1 and 2:

(1) 76 per cent of those ' at risk ' at the end of the first term completed the session successfully;

(2) 40 per cent of unsatisfactory students were not identified by the early warning system.

(A) *Comparison of (i) those at risk who were subsequently unsatisfactory and (ii) those at risk who were subsequently not unsatisfactory.*

Although the majority of students at risk did manage to avoid being declared unsatisfactory, a breakdown of their performance in the degree examinations shows that 140 of the 188 (74 per cent) had experienced some difficulty in obtaining the required number of passes (Table 3). Only 48 of the 188 ' at risk ' students passed in all subjects at the first attempt in June 1975.

The comparison between ' at risk '/unsatisfactory and ' at risk '/ recovered was restricted to first and second year students and excluded those who were allowed to continue although unsatisfactory and those who withdrew voluntarily from university before any order was made against them (see Table 4).

TABLE 3

Outcome of End-of-Session Examinations for the Students at Risk.

Year	All subjects passed in June	All subjects passed by September	Some failure or no class certificate	Unsatisfactory discontinued	Unsatisfactory continuing	Voluntary withdrawal
1	25	15	32	31	2	4
2	16	10	19	12	1	3
3/4	7	3	3	2	1	2
Total	48	28	54	45	4	9
Total experiencing difficulties: 140.						

TABLE 4

Numbers at Risk by Outcome of Session.

Year	At risk—recovered	At risk—unsatisfactory	Total	At risk—unsatisfactory continuing or voluntary withdrawal	Total
1	72	31	103	6	109
2	45	12	57	4	61

TABLE 5

Outcome at End of Session, by Various Characteristics. (Percentages by row in brackets).

	1st year students		2nd year students	
	At risk—recovered	At risk—unsatisfactory	At risk—recovered	At risk—unsatisfactory
		3 n/a		1 n/a
SCE passes:				
4 or less	29 (69)	13 (31)	16 (80)	4 (20)
5 or more	42 (72)	16 (28)	28 (78)	8 (22)
		43 n/a		24 n/a
CSYS:				
1 or more	21 (81)	5 (19)	17 (77)	5 (23)
No CSYS	20 (59)	14 (41)	9 (82)	2 (18)
		2 n/a		10 n/a
Head's report:				
Favourable	45 (74)	16 (26)	26 (81)	6 (19)
Reservations	26 (65)	14 (35)	11 (73)	4 (27)
		20 n/a		6 n/a
Adviser's estimate:				
High ability	4 (44)	5 (56)	5 (62)	3 (38)
Average	31 (72)	12 (28)	21 (91)	2 (9)
Low ability.......	22 (71)	9 (29)	15 (75)	5 (25)

Other categories (sex, direct entry from school/mature entrant, entry from 5th year of school/6th year, Arts/Science bias at school, degree of 'at risk' in first term examinations, university residence at home/lodgings/hall/flat, home area, adviser's prediction of outcome) also showed no significant differences between those 'at risk, recovered' and 'at risk, unsatisfactory.'

The purpose of the comparison was to try to identify the characteristics which are associated with successful ' recovery ' after a poor first term. Table 5 sets out a selection of the results of comparisons by sex, entrance qualifications (in various forms), headmaster's report, degree of risk in first term, residence, home area, and adviser's assessments.

None of these offers much hope of identifying clearly the characteristics which differentiate successful recovery from eventual failure. Perhaps the most hopeful is a successful attempt at the Certificate of Sixth Year Studies (CSYS), for first year students only, where those with at least one CSYS pass clearly did better than those without.

Almost all ' at risk ' students were seen by advisers between Christmas, 1974 and March, 1975, and during the adviser interviews, advisers were asked if they knew of any explanation for the poor term performance of their ' at risk ' students. In many cases, the students had volunteered explanations, sometimes advisers themselves suggested alternative explanations and in some instances neither adviser nor student was able to put forward possible causes.

The factors most often mentioned were subject difficulty, lack of application, transition problems (school or work to university), domestic and/or personal difficulties, lack of motivation and disorganised study habits. ' Lack of application ' was mentioned more frequently by failing first year students, and ' subject difficulty ' mentioned more frequently by those who eventually succeeded; but overall, *again none of the factors showed any clear differentiation between recovery and failure.*

(The limitations of this type of approach must of course be emphasised: often the explanations provided by advisers were subjective opinion or simply guesswork, the extent of which depended greatly on the nature of their relationship with the student and on their own view of their roles as advisers.)

(B) *Failing students not identified as at risk.*

The number of students missed by the early warning procedure (who were unsatisfactory at the end of session but had not been identified as at risk after the first term examinations) was 30. 16 of these were first year students, 12 were in second year and 2 in third or fourth year. 19 of the 30 had been in the bottom third of the class in only one subject in the first term examinations but their performance in other subjects was satisfactory. The other 11 achieved a satisfactory result in all subjects in the first term examinations.

Advisers were again contacted to attempt to find an explanation for the poor performance of these students in the degree examinations. Several of the students had not seen their advisers since the degree examinations (despite advisers' attempts to contact them) and no explanation was forthcoming from them.

Frequently advisers were at a loss to speculate about unsatisfactory degree performance, except in the cases of students who had experienced personal or domestic difficulties at some stage between the end of the first term and the degree examinations. Where tentative explanations were given either by adviser or student or both, the pattern of responses was similar to that reported in Section 1. *No one factor or group of factors emerged to account for the unpredictable failure of these students.* As many explanations of failure were given as there were students in the group.

(C) *Second year students at risk.*

As the inquiry progressed, it became clear that failure tends to be cumulative in its effect, and therefore the first year records of second year students in difficulties might provide a helpful aid to prediction. Do students in difficulty in second year show consistently weak performance throughout their period of study, or is there a category of student who reaches a ' ceiling ' after a satisfactory first year? The figures in Table 6 indicate that the unexpected collapse in performance is relatively rare. Of 55 students at risk in second year, only 19 had completed their first year successfully, and only two of these were unsatisfactory at the end of second year. Of the remainder, the majority were carrying one subject which they had failed in first year, and about one in four of these were unsatisfactory in second year. Merit certificates in first year subjects had been gained by only three of these 55 students, and these three completed second year satisfactorily. Advisers reported five students as ' difficult to contact'; and all five either were unsatisfactory or withdrew voluntarily during the second year.

TABLE 6

1st Year Performance of 2nd Year Students at Risk.

	2nd year performance		
1st year performance	At risk—recovered	At risk—unsatisfactory	Total
All 1st year subjects passed by Sept....	17 (89)	2 (11)	19 (100)
One 1st year subject failed	22 (76)	7 (24)	29 (100)
1st year unsatisfactory	5 (71)	2 (29)	7 (100)
TOTAL	44	11	55

Percentages by row in brackets.
Excluding two students who transferred from other universities.

DISCUSSION

The results of the enquiry do not offer much hope of improving the early warning procedure. None of the factors studied differentiated clearly between those who eventually succeeded and those who failed. No worthwhile alternative to the criterion of poor class examination performance was found, although the CSYS record of the student may prove to have a fairly significant relationship with his success at university. (Perhaps the standard in certain ordinary class subjects is being raised, either consciously or unconsciously, to accommodate students with CSYS in these subjects, to the detriment of those without.) Among second year students, there is a 1 in 4 probability of failure for those who have to carry one failed subject and are then identified as ' at risk ' after the first term examinations.

Insofar as the early warning procedure is successful in helping students to ' recover ', it is self-defeating in its predictions. The fact that 40 per cent of failing students are missed by the net, is a more serious matter than the 76 per cent success among those ' at risk.' To identify the missing 40 per cent, it would be necessary to cast the net much more widely. The problem is still the same as that discussed in our original 1966 papers: " to find a balance which identified a majority of the failures without including too many others who completed the year successfully " (Nisbet and Welsh, 1966, p. 478).

Thus, within the present examination structure, we cannot improve the accuracy of prediction in the early warning procedure. As long as there is an element of uncertainty around the pass mark in degree examinations, the accurate forecasting of failure is unattainable (perhaps fortunately). Previous work in Aberdeen (Wilson, 1971; Nisbet, 1971; Entwistle and Wilson, 1976) has shown that it is easier to predict the ' high fliers ' than the failures. Possibly the value of the early warning system is not in prediction but as a demonstration of awareness and concern. It alerts students, and communicates to them an attitude of concern about their performance and their problems. It provides information to advisers as a basis for this concern; and the present survey suggests that the system is unlikely to be improved by additional information or by sophisticated analyses of records. The solution does not lie in refining the instruments of prediction in an absurd hope of ultimately finding a technique for classifying our students in exactly the same order of merit throughout the course. The attempt to devise a method of perfect separation of good students and bad students suggests the calculation of the orbit of a satellite: if one knows the student's velocity, direction and density, his path is assumed to be predictable. This would be true only if the student were inert, and the university through which he passes is, like outer space, vacant and sterile. " Research offers an aid to intelligent decision-making, not a substitute for it. Research brings relevant information rather than uniquely exclusive conclusions " (Halsey, 1972, p. 179). Without the existing early warning system, however—despite its weaknesses—and the backing it received from advisers of study, perhaps many more of the 188 ' at risk ' students identified at Christmas by the system would have ended up as unsatisfactory students.

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THE IDENTIFICATION OF SOME CREATIVE THINKING PARAMETERS COMMON TO THE ARTISTIC AND MUSICAL PERSONALITY

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SUMMARY. The intent of this study was to explore several segments of divergent intelligence, visual stimulus complexity as a cognitive style, and auditory acuity, that presumably characterise the artistically expressive person. The sample population was comprised of 34 visual artists, 32 musical artists, and a normative group of 30 undergraduate university students. Between-group differences were examined by way of ANOVA, multiple discriminant function analysis, and then by a principal components solution (with varimax rotation). Preference for visual stimulus complexity was upheld as a cognitive style dimension common to both artistic and musical personalities. Substantive evidence was found to confirm the 'divergent auditory figural memory factor' (DFS-A) posited by Guilford in his SI model. As conjectured, visual artists displayed a superior propensity on the triadic divergent abilities subsumed under fluency, flexibility, and originality of thinking, while musical and control subjects were undifferentiated on these cognitive parameters. More importantly, the heightened auditory acuity and aesthetic judgment of visual artists over that of controls, as measured by the pilot auditory discrimination test, indicates the existence of a general intersensory factor among creative artists. Similarly, the musician's sensibility and attraction to complex abstract imagery beyond that of their non-artistic peers further strengthens the notion of possible shared perceptual features by creative individuals across discrete sensory modalities. Overall, the selected variables were shown to be reliable predictors for identifying the artistically gifted individual.

INTRODUCTION

DURING the last 25 years, the creativity literature has been replete with numerous studies offering the reader a plethora of validating criteria seemingly devoid of any unitary definition of ' creativity ' that has gained universal acceptance. Golann (1963) highlights its denotative versatility : " Creativity is a normally distributed trait, an aptitude trait, an intrapsychic process, and a style of life." One pragmatic approach towards measuring creative talent has been Guilford's (1950, 1954) factor analytic identification of a divergent-convergent continuum comprised of eight primary cognitive attributes, later incorporated into his SI model. Torrance (1966) later adopted and modified essentially Guilford-like tests by developing multifaceted tests of divergent intelligence. However, both investigators have relied primarily upon static test items, rather than adequately exploring the sequential or integrative processes underlying creative expression.

In the cognitive domain of personality, preference for stimulus complexity was originally introduced by Welsh (1949) as a perceptual style variable with possible implication for diagnosing psychopathology, and concomitantly conceptualised by Frenkel-Brunswik (1949) as an emotional-perceptual ' tolerance of ambiguity.' This bipolar style dimension has since been empirically validated by Barron and Welsh (1952) as fundamental to the artistic personality, and further shown to be associated with criterion ratings of originality, rated mosaic productions, and preferences for aesthetically pleasing works of art (Barron, 1953; Barron and Hall, 1972). Cross-culturally, Raychaudhuri (1963) has demonstrated the efficacy of the Revised B-W Scale for assessing preference for visual stimulus complexity not only among highly gifted, commercial and fine arts students, but also between painters and musical persons (Raychaudhuri, 1966). Interestingly, while both Raychaudhuri (1963) and Rosen (1955) point out that varying levels and different types of art instruction all appear to have a negligible effect upon obtained preference scale scores, Eysenck (1972) provisionally states that specific training programmes directly affect superior aesthetic sensitivity scores and polygonal preferences.

One noteworthy criticism of the Barron Welsh Art Scale arises from Eysenck and Castle (1970) who factor analysed the 86 drawings and obtained one simplicity factor and three orthogonal complexity factors rather than a single, bipolar continuum. However, partitioning the complexity component into three constituent factors seems unjustified from a content analysis of the items, especially since the data is in binary form and no communalities or eigen values for the extracted factors were reported.

Expanding previous findings, this study seeks to extend the view that artistically expressive individuals tend to develop a marked preference for, and superior acuity within, varying sensory modalities beyond that of non-artistic persons. It is anticipated that the proclivity to cognise differences in visual stimulus complexity will be related to the ability to detect subtle nuances through the auditory modality, thus indicating some intersensory transference. This conjecture receives theoretical support from Berlyne (1971) who contends that every work of art embodies rhythm and metre as its rudimentary features. He argues that " temporal periodicity and sub-division into similarly structured groupings can be expected to characterise many of the acts by which the painter, sculptor, draughtsman, or carver produces his work, as well as the motions of the dancer, performing musician or reciter " (pp. 237-8).

Earlier, Burt (1933) suggested that, apart from irrelevant associations of fashions, fancies, and fads, there may exist some fundamental guiding principles that direct the idiosyncratic choices of individuals in their selection of aesthetically pleasing art forms. Developing this logical premise, Williams *et al.* (1938) obtained evidence of a general aesthetic appreciation factor common to tests of literary, pictorial, and musical preferences, while Eysenck (1940, 1941) identified a set of bipolar, aesthetic appreciation, or ' good taste ' factors that extend across the visual and olfactory modalities, using pictorial, odorific, achromatic, and polygonal stimuli. In a continuation of this research theme, Eysenck (1972) furnishes additional evidence of the artist's sensibility for making refined aesthetic judgments. Similarly, Barron and Hall (1972) showed that, among San Francisco Art Institute students, flexibility, originality, and preference for perceptual complexity were significantly related to visual aesthetic judgments.

The Auditory Modality In Intellectual Functioning.

Apart from Cattell's work on musical preferences and relating these to personality dynamics (Cattell and Anderson, 1953; Cattell and Saunders, 1954), little effort has been directed towards indexing musical aesthetic appreciation, auditory discrimination patterns, or modes of intersensory integration to divergent intellectual abilities. Partly to overcome the neglect of the auditory modality in creativity research, Guilford (1957, 1967) has proposed a dichotomous figural memory factor within his SI model, comprised of discrete auditory and visual cells. While these abilities can logically be isolated as separate entities, they are surmised to be intercorrelated and also integrally related to various creative pursuits exemplified by the choreographic, artistic, or musical performer. One of the few attempts to devise an analogous set of pilot instruments to measure the dichotomous cell of Guilford's figural memory factor, visual (DFS-V) and auditory (DFS-A), is reported by Hare and Gaier (1971), albeit, by the authors' own admission, the auditory task involved reorganisation of dot-and-dash, morse code symbols that were just visually presented to subjects, thus totally bypassing the auditory channel.

To explore auditory information processing, a pilot discrimination test was constructed to gauge a number of auditory-perceptual processes and aesthetic sensitivity, so as to identify some of the underlying processes that might facilitate (or mediate) creative expression.

METHOD

Sample.

A total of 96 male and female undergraduate students took part in this study. The artists (painting, graphic, sculptural, and photographic) were enrolled at the Ontario College of Art, Toronto. Musicians were recruited from three recognised training centres, namely, the Ontario Conservatory of Music, University of Toronto; Department of Music, York University; and the Kelso Music Centre, Sheriden College of Art, Oakville, Ontario. A control group of 30 university students registered as general arts and science majors (sociology, business administration, law, history, economics, political science, and English departments) were assembled from York University and the University of Toronto. The subjects were relatively homogeneous with respect to age (range= 18-25, mean=21·8 years), formal education level, cultural background, and sex distribution. Previous experience and sophistication effects were controlled for, so that neither any artist nor control candidate had any specialised musical expertise and, conversely, no musician or control subject had been exposed to any formal art training which might obfuscate the results. All subjects were volunteers and the tests were administered in a relaxed, small group atmosphere as suggested by Torrance (1966) and Vernon (1973) to facilitate optimal performance.

Psychological Tests.

(1) Torrance Tests of Creative Thinking.

Torrance's (1966) tests of divergent intelligence were employed to assess the production factors labelled ideational fluency, flexibility and originality of thinking. The seven sub-tests involve: Asking Questions, Guessing Causes, Guessing Consequences, Product Improvements, Unusual Uses of Objects, Unusual Questions, and Hypothetical Dilemmas. All of the test protocols were scored by two independent raters to result in a inter-rater reliability coefficient in excess of + ·90, thus conforming to the accuracy expected in the scoring manual.

(2) Revised Barron-Welsh Art Scale (RA-WFPT).

The RA-WFPT was chosen to evaluate the cognitive style dimension commonly known as preference for visual stimulus complexity. Here, the subject records his ' like ' or ' dislike ' for each of 60 figure drawings, 30 of which are depicted as intricate, abstract designs most often preferred by artists, and 30 symmetrical, geometric shapes seldom selected by artists.

(3) Mundinger Musical Perception Test—Pilot Version.

An experimental auditory discrimination test was devised to assess some of the auditory-perceptual processes deemed relevant to creative musical expression. The stimuli consisted of pure tone signals, piano excerpts, and orchestral melodies that were all pre-recorded onto magnetic tape utilising high fidelity electronic equipment. Small group testing was carried out under identical conditions by taped administration to eliminate the fortuitous problems inherent in irregular dictation of rhythms, variable chord accentuations, and vacillating decibel levels. The following sub-tests were included:

1. *Melodic Discrimination*: The ability to discern similarities and subtle incongruities between two or more melodies.
2. *Auditory Perception*: The capacity to direct and sustain attention to a series of pure tone stimuli presented against a background of distracting musical material.
3. *Aesthetic Judgment*: The ability to select the most aesthetically pleasing musical composition from closely paired items comprised of the original version of a passage written by a notable composer, and a distorted less-harmonious version.
4. *Perceptual Awareness*: The capacity to cognise similarity of compositional style between excerpts extracted from popular musical works.
5. *Rhythmic Perception*: The ability to detect similarities between barely dissimilar pairs of musical rhythms presented at various frequencies and decibel levels.
6. *Auditory Memory*: This bimodal coding task requires the subject to recall rhythmical patterns embodied in conventional musical pieces, and to reproduce these as graphic linear symbols or morse code notation (e.g., – –. – – –), so as to provide a measure of Guilford's divergent figural systems (DFS-A).
7. *Rhythmic Integration*. This alternate cross-model coding task calls upon the subject to perceive musical metre by identifying accentuations, or by discriminating subtle nuances in harmony, and to reproduce these in the form or ordinal, symbolic units (e.g., beat patterns of 12, 123, 1234, etc.). This, too, is expected to depend on Guilford's 'divergent rhythmical auditory figural memory' (DFS-A).

Statistical Analysis

Initially, analyses of variance were employed to test between-group mean differences for all criterion variables. As a second step, the overall correlation matrix was submitted to a principal components' factor analysis using the SPSS series of programs (Nie *et al.* 1970). A varimax orthogonal solution provided the clearest description of the data matrix with a minimum of overlap between factors. Lastly, a stepwise discriminant function analysis was performed on the total test battery using the BMD package of computer programs (Dixon, 1972). This latter procedure computes a set of lambda weights that, when applied to the raw scores on the variables for individual subjects, produces a standard score for each case (Wheeler, 1964). By fitting linear discriminant functions to the data, multivariate differences between the three population samples were used to categorise each individual as belonging to one group or another.

RESULTS

Correlations and ANOVA:

The means and standard deviations are presented in Table 1 and illustrate substantial between-group differences on the criterion measures.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR THREE GROUPS ON SELECTED CRITERION VARIABLES.

	Control Group		Musicians		Artists	
	mean	SD	mean	SD	mean	SD
1. Fluency	67·07	16·83	70·41	16·92	88·32	21·67
2. Flexibility	46·03	14·76	51·94	13·82	56·00	12·54
3. Originality	42·40	14·60	44·19	12·94	60·76	15·83
4. Stimulus Complexity	24·07	5·50	32·38	10·21	42·12	5·22
5. Melodic Discrimination	4·93	1·62	7·94	1·39	6·71	2·20
6. Auditory Perception	5·57	2·30	7·50	2·09	6·88	1·65
7. Aesthetic Judgment	5·80	2·09	9·13	1·83	7·18	2·10
8. Perceptual Awareness	5·10	1·92	7·38	1·64	6·76	1·84
9. Rhythmic Perception	4·47	2·03	7·88	1·52	4·32	2·84
10. Auditory Memory	2·87	1·83	11·28	3·37	4·53	3·93
11. Rhythmic Integration	5·37	2·08	8·69	2·52	7·71	2·52

Table 2 details the Pearson product-moment coefficients for the three combined groups. As anticipated, the intercorrelations between the three creativity factors emerged as highly significant (+·79, +·80, +·85). The B-W liking for perceptual complexity variable, too, correlated in the +·40 range with the Torrance production factors. An important finding was that, with the exception of aesthetic appreciation, none of the auditory variables was significantly related to the divergent intelligence measures, suggesting that musical attributes represent an orthogonal dimension. However, the positive relationship between aurally-mediated aesthetic judgments and flexibility of thinking is suggestive and worthy of further research. Also, low but significant coefficients were obtained between stylistic preferences for complex abstract imagery and auditory sub-test factors of melodic discrimination, aesthetic judgment, and rhythmic integration. Thus, some tenuous associations exist to link the visual and auditory style dimensions on an intersensory level. Between the musical sub-tests, the strongest relationships are obtained by auditory memory (divergent figural production) with rhythmic perception (+·69), and with melodic discrimination (+·50); rhythmic integration (divergent figural production) with melodic discrimination (+·47), and with auditory memory (+·41) and, lastly, aesthetic appreciation with melodic discrimination (+·34).

A univariate analysis of the divergent production factors shows that artists and musicians were significantly dissimilar ($P < \cdot 01$), with artists earning the highest overall creativity scores. While artists also surpassed controls, musicians were not distinguishable from control subjects on the three aspects of divergent intelligence. It is of interest also that the artists significantly surpassed the musicians on fluency and originality, yet no such distinction occurs for flexibility of thinking.

On the complexity-simplicity style dimension, artistic persons demonstrated the greatest preference for visually abstract stimuli, followed by musicians who were closer to artists than to controls.

TABLE 2

RAW SCORE INTERCORRELATION MATRIX

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Fluency	1·00										
2. Flexibility	·80**	1·00									
3. Originality	·85**	·79**	1·00								
4. Complexity	·47**	·44**	·49**	1·00							
5. Melodic Discrimination	·08	·12	·01	·31*	1·00						
6. Auditory Perception	·12	·16	·14	·20	·28*	1·00					
7. Aesthetic Judgment	·08	·24*	·16	·23*	·34**	·16	1·00				
8. Perceptual Awareness	·18	·17	·15	·19	·33*	·28*	·24*	1·00			
9. Rhythmic Perception	—·18	·04	—·15	—·00	·32*	·16	·23*	·19	1·00		
10. Auditory Memory	—·00	·14	—·06	·12	·50**	·27*	·34**	·33*	·69**	1·00	
11. Rhythmic Integration	·04	·15	·08	·27*	·47**	·11	·26*	·30*	·30*	·41**	1·00

* P= ·05 (r.= ·21) **P= ·01 (r.= ·27) (df=94, two-tailed test)

TABLE 3

ANALYSES OF VARIANCE FOR MEAN VECTOR CONTRASTS

Variable	Group Contrasts	F	DF	P<
Fluency	A *vs.* M	13·90	1/64	·01
	A *vs.* C	18·84	1/62	·01
	M *vs.* C	·61	1/60	·44 NS
Flexibility	A *vs.* M	1·57	1/64	·22 NS
	A *vs.* C	8·53	1/62	·01
	M *vs.* C	2·65	1/60	·10 NS
Originality	A *vs.* M	21·54	1/64	·01
	A *vs.* C	23·06	1/62	·01
	M *vs.* C	·26	1/60	·61 NS
Stimulus Complexity	A *vs.* M	24·23	1/64	·01
	A *vs.* C	100·95	1/62	·01
	M *vs.* C	15·61	1/60	·01
Aesthetic Judgment	A *vs.* M	16·12	1/64	·01
	A *vs.* C	6·89	1/62	·01
	M *vs.* C	44·60	1/60	·01
*Musical Perception Test	A *vs.* M	18·02	7/58	·01
	A *vs.* C	6·64	7/56	·01
	M *vs.* C	27·56	7/54	·01

* Multivariate contrasts

Code: A=Artists M=Musicians C=Controls

For the musical perception test, musicians registered the keenest auditory discriminations, succeeded firstly by artists and then controls (P< ·01). The three groups were also statistically disparate from one another on the aesthetic appreciation measure. Notably, visual artists made more accurate aesthetic judgments of musical phenomena than did their university counterparts. Tentatively, these conjoint findings suggest that both musical and visual artists share a common sensitivity for aesthetically pleasing musical forms and visual stimulus complexity.

Factor Analysis:

Statistically, only two factors with an eigen value greater than unity (1·0) emerged, the implication being that only these factors and their loadings are significant (Guttman, 1954). However this criterion was relaxed as the next four factors each accounts for no less than 6 per cent of the common variance, even though their eigen values are slightly less than unity. Table 4 presents the six extracted factors that accumulatively accounted for 85 per cent of the total variance. Conservative factor loadings of ·40 and over were accepted for interpretation, following the recommendation of Cattell (1957).

Factor 1—Divergent Production: Perceptual Style.

This was comprised of the B-W liking for stimulus complexity and the cognitive production factors of fluency, flexibility, and originality of thinking. That such highly weighted coefficients have been subsumed under a unitary factor prompts the question of whether divergent intelligence is indeed multidimensional, or if a general factor of creativity exists, *per se*. The results are clear cut and strongly suggest that these elements of creative expression and perceptual style are interwoven into a common factor.

TABLE 4

PRINCIPAL COMPONENTS ANALYSIS AFTER VARIMAX ORTHOGONAL ROTATION WITH KAISER NORMALISATION (N=96)

Variates	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI
Fluency	·95*	—·09	·02	·08	—·06	·09
Flexibility	·89*	·11	·05	·06	·17	·02
Originality	·91*	—·11	·03	·08	·08	·07
Complexity	·47*	—·04	·34	·16	·16	·01
Melodic Discrimination	·02	·26	·53*	·29	·22	·12
Auditory Perception ..	·10	·13	·06	·55*	·08	·11
Aesthetic Judgment ..	·12	·19	·20	·13	·50*	·09
Perceptual Awareness	·11	·15	·23	·28	·13	·47*
Rhythmic Perception	—·10	·79*	·15	·09	·10	·02
Auditory Memory	·01	·81*	·24	·19	·16	·17
Rhythmic Integration	·06	·25	·66*	·03	·14	·14
Per cent of Variance	31·80	23·50	8·50	8·20	6·90	6·60
Eigen Values	3·50	2·59	·94	·91	·76	·72

† Eigen values and proportion of variance as calculated from the unaltered correlation matrix.
* =significant factor loadings above ·40.

Factor 2—Rhythmic Perception: Auditory Memory

This factor has two significantly high loadings on auditory memory (+·81) and rhythmic perception (+·79). It would appear that there is an associative bond between the detection of complex rhythms between musical passages and the ability to recall, organise, and reproduce auditory sound patterns in the form of morse code symbols. Since the auditory memory task requires the subject to translate rhythmical stimuli into graphic symbolic notation, this factor confirms Guilford's contention that divergent auditory figural systems involve memory for both musical melodies and rhythms. In light of the proportion of the variance explained by this factor (S^2=23·5 per cent, latent root=2·59), it would appear that this two-fold auditory transformation faculty is the most potent characteristic of the musical variables under investigation.

Factor 3—Melodic Discrimination: Rhythmic Integration

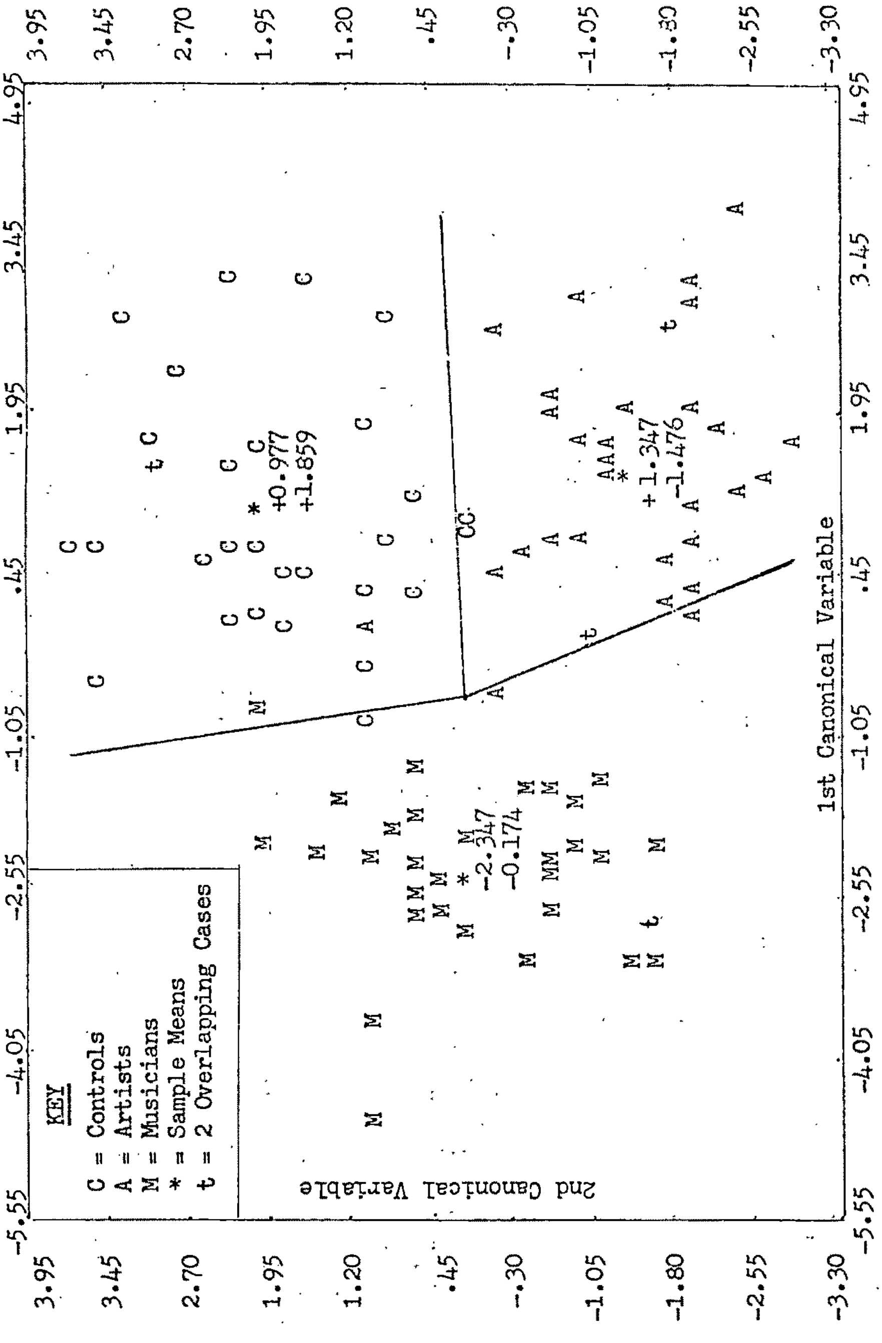
This factor is defined by moderate coefficients on melodic discrimination (+·53) and rhythmic integration (+·66). Apparently, the ability to perceive slight similarities and discrepant nuances between musical melodies is related to the capacity to transform autonomous sound patterns into numerical symbolic units. Seemingly, the process of transforming musical metre into ordinal symbols represents a different mode of figural transposition, apart from that defined by factor 2, that is also intrinsic to Guilford's portrayal of DFS-A.

Factor 4—Auditory Perception.

Only a positive loading on auditory perception emerged as interpretable. Seemingly, this discrete factor implies the propensity to focus upon and select a relevant auditory stimulus from a background of irrelevant stimuli, and to continue this selectively sustained attention for varying periods of time. The unitary nature of this auditory perception factor suggests that this capacity is reasonably independent of (although not wholly uncorrelated with) both divergent expression and its companion auditory sub-test variables.

FIGURE 1

PLOT OF CANONICAL VARIATES



NOTE: Three hyperplanes intersect at one point. They divide the plane into 3 population regions, each of which has a certain rank order for the posteriori probabilities.

Factor 5—Aesthetic Appreciation

This factor denotes preferences for aesthetically pleasing contemporary and classical musical compositions as opposed to slightly, distorted, dissonant versions of the composers' original masterpiece.

That aesthetic judgment crops up as largely independent does not preclude its relatedness to alternate cognitive variables such as flexibility of thinking ($r = \cdot 24$, $P. < \cdot 05$) or preference for abstract stimulus complexity ($r = \cdot 23$, $P. < \cdot 05$).

Factor 6—Perceptual Awareness.

This specific factor characterises a sharp receptivity to, and keen discrimination of, compositional styles despite superficial similarities amongst varying composers. Again, it appears that this is a specialised ability unrelated to the cognitive and perceptual style dimensions of creative expression.

Multiple Discriminant Function Analysis:

A plot of the canonical variates was formed to contrast the ratio of predicted *versus* actual group membership. The three discriminant functions (D_1, D_2, D_3) are represented in Figure 1 and roughly delineate the mutually exclusive population regions corresponding to the two-dimensional vector space inhabited by musical, artistic, and control group subjects. Given the assumption that *a priori* probability values are equal for membership in any of the three sample populations, an individual is assigned to that group for which the computed probability density is largest. Entries within the main hyperplane diagonals denote correct classifications or ' hits ', while entries outside the specified boundaries represent misclassifications. For the 96 cases, only seven were incorrectly assigned, yielding a predictive accuracy of 92·7 per cent. A chi-square test (Rao, 1952) based on the Mahalanobis D^2 value of 408·14, with 22 df, showed that the differences between the means for all three groups on the omnibus test battery were significant at the ·001 level.

DISCUSSION

The visual artists displayed a superior ability for associating remote ideational concepts, versatility of creative expression, and generated more original responses in their test protocols than either musicians, or controls who earned the lowest scores. This finding suggests that visually and musically expressive individuals are distinctively unique on these cognitive parameters of divergent intelligence. Since the Pearson r's among the Torrance variables are high (+·79, +·80, +·85), this calls into question the alleged ' construct validity ' of Torrance's tests, as they claim to measure three distinct aspects of divergent intelligence. The writers concur with Vernon (1964, 1973) who suggests that there seems to be little need for multiple scoring procedures of such highly intercorrelated abilities. In a similar vein, Clark and Mirels (1970) have commented that "...where high correlations are found among indices of creativity, the size of these correlations is frequently attributable to fluency which influences all scores."

Clearly, visual artists registered the most pronounced perceptual attractions for intricate figural complexity. By way of comparison, musical artists also tended to select complex figure drawings more frequently than liberal arts students, thus supporting Raychaudhuri's (1966) and Hare and Gaier's (1971) findings using similar population samples. Despite the musicians' primary reliance upon the auditory sense modality, their attraction to complex visual stimuli over that of non-artistic peers lends credence to the notion that creative individuals, regardless of their avocations, share a heightened perceptual discrimination across sensory modalities that is not masked by superior acuity in their preferred modality.

Given that musicians logically surpassed all others on the pilot auditory perception tests, one important finding was that visually expressive artists were more keenly sensitive to auditory stimuli than control subjects. This further adds to the contention that visually alert artists are responsive to, and can extract, almost imperceptible auditory cues from musical phenomenon, thus pointing to the need for further confirmatory research to unravel the cognitive processes underlying intersensory transference, in a similar vein to that postulated by Eysenck (1940).

The auditory aesthetic judgment factor was found to have low but significant correlations with associative flexibility, preference for stimulus complexity, and five out of the six auditory discrimination measures, excluding auditory perception. This moderate relationship of aurally-mediated aesthetic appreciation with the preceding variables is analogous to the research findings reported by Barron (1953) and Barron and Hall (1972) that linked originality, visual complexity, and visual aesthetic sensitivity. It lends credence to the notion of a general aesthetic appreciation factor that cuts across sensory modalities as suggested by Burt (1933), Williams *et al.* (1938) and Eysenck (1940, 1941, 1972). Moreover, this finding extends the idea of a pervasive cross-modal factor to include musical judgment abilities. Likewise, the interrelationships of the cognitive style dimension with auditory aesthetic appreciation and rhythmic integration are in accord with Berlyne's (1971) statement that much figurative and abstract art necessarily involves rhythm.

The auditory memory-rhythmic perception factor delineates the memory component of divergent figural systems espoused by Guilford (1957, 1967) and experimentally demonstrated by Karlin (1941) with undergraduate students. Alternatively, the third factor loadings of rhythmic integration and melodic discrimination are synonymous with Guilford's (1957) proposition that DFS-A involves sensory integration and recollection of melodies and rhythms.

CONCLUSION

Notwithstanding the obvious difficulties encountered in objectively measuring creative expression, an experimental auditory discrimination test, a set of divergent production measures, and the Barron-Welsh Art Scale were efficacious in showing that artistic and musical persons possess or develop similar cognitive attributes, although they can be distinguished from one another and from other university peers. Thus, among creative individuals, there appears to exist a shared artistic and musical sensibility for sensory phenomenon within discrete modalities.

However, it is important to qualify our findings by pointing out that sophisticated multivariate procedures cannot, in themselves, identify the salient features of the creative process so long as the theoretical foundations of the field remain, vague, inconsistent, and loosely formulated.

Despite the renewed and mounting enthusiasm for the current bandwagon of creativity, much spadework remains to be done towards identifying reliable external criteria and designing sensitive psychometric methods to gauge 'process' rather than 'static' descriptors, and thereby avoid the pitfalls of merely evaluating the convergence-divergence dichotomy. It can be provisionally stated that creative persons portray an elevated sensory acuity across sensory modalities. If true, the multisensory experimental design is a vital focal point that has suffered psychological neglect.

No doubt, some modicum of intra-intersensory integration must fundamentally occur to enable a host of diverse personality types . . . like painting artists, musical composers, literary poets, sculptors, designers, and research scientists all to perceive ratios, proportions permutations, and aesthetically pleasing relations in the mind's eye . . . so as to culminate in the birth of an imaginative Gestalt.

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THE DISTINCTIVENESS OF OPERATIVITY AS A MEASURE OF COGNITIVE FUNCTIONING IN FIVE-YEAR-OLD CHILDREN

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SUMMARY. A battery of 28 individually administered tests, comprised of measures derived from the work of Piaget, of simple and complex learning, of language, STM, LTM and intelligence were given to 210 children aged 5·6 to 6·0 during their first year of schooling. The children were drawn from 21 schools: seven schools from each of three areas rated as privileged, average and underprivileged. Factor analysis revealed seven significant factors amongst which were separate ones for language and operativity. The latter is defined and the usefulness of the Piagetian measures is discussed as is their relationship with the other measures, and the sensitivity of all measures to influences associated with socio-economic status.

INTRODUCTION

THIS paper is the first of two based on a partially longitudinal enquiry involving 210 children and using a total of 28 measures. The children were carefully chosen to represent the full range of differences associated with socio-economic background within the context of a native-born English upbringing. The present paper is an assessment of the measurability of operativity, and its distinctiveness as compared with measures of language and memory. In addition, consideration is given to the question whether, having regard to the well substantiated correlation between social class and intelligence, the Piagetian approach offers a means of measuring an ' intelligence ' which is less subject to the effects of environmental factors associated with socio-economic status. The prediction of scholastic attainment is the subject of a second paper in this *Journal* (Lunzer, *et al.*, 1976).

Piaget's clinical method was elaborated in opposition to the principles and practice of psychometric testing on the grounds that it is more important to be clear about what one is measuring than it is to be accurate. The criticism might well appear to be justified by the theoretical confusion surrounding the concept of intelligence as seen in psychometrics. But the opposition between these contrasting viewpoints rests in part on a semantic confusion. The word ' intelligence ' has a twofold connotation. One of its usages refers to intellectual capacity as a measure of individual difference. It also has another usage which is quite different, as in the compound ' naval intelligence,' when it is roughly synonymous with ' knowledge.' It is the latter usage which is predominant in the work of Piaget, while psychometricians are mainly interested in the former. But although the opposition of viewpoints is more apparent than real, its very existence covers up certain deficiencies in the work of both schools: some neglect of psychological theory in the construction of intelligence tests, and inattention to individual differences as well as procedural rigour in the work of the Genevan school. It is therefore not surprising that attempts are now being made to bring about the rapprochement between the two schools of thought, most notably perhaps in the design of the British Intelligence Scales (Warburton, 1970).

Nevertheless, these attempts are still sporadic, and this is unfortunate in that Piaget's ideas constitute the most important single advance on the pioneering insights of Spearman, who was at once one of the founders of intellectual measurement and probably the most creative thinker in regard to the formulation of an acceptable definition of intelligence first published in 1923. Spearman's noegenetic principles, apprehension of experience, education of relations and education of correlates continue to serve as the principal theoretical underpinning for the design of intelligence tests, explicitly in the case of Raven's Matrices (still the most influential and widely used non-verbal test), implicitly in the majority of measures used in this country. More recent theoretical developments have for one reason or another proved far less influential. Guilford's ambitious programme (1959, 1967), founded on the categorisation of input, process and output, yields a multiplicity of specifics which fails to do justice to the overall unity suggested by most studies in the field. Cattell's distinction between fluid and crystallised intelligence (cf. Horn, 1968) points to important differences between tests that derive from Spearman and those that owe more to Binet, but contributes little to the elucidation of the concept of intelligence beyond what was advanced by Spearman. The same might be said of the differentiation of power and speed in the work of Furneaux (1956) and Eysenck (1967).

What might seem to be the most promising line of advance is the attempt to identify intellectual differences with the ability to learn. A number of relevant studies have proved unsuccessful (Woodrow, 1946; Mackay and Vernon, 1963), due mainly to the difficulty of separating out the role of intelligence in initial attainment from its role in subsequent learning. However, Duncanson (1964) did find evidence for three factors which were common to learning tasks and achievement measures, as well as others which were specific to one group or the other. Jensen (1964) obtained relatively high correlations between achievement measures, short-term memory and serial learning. Both of these latter tasks are far removed from the notion of intelligence as all-round mental ability. In terms of an important distinction made by White (1965), they do not require transformation of input. Transformational structures should be relatively less dependent on input than storage and retrieval. One might therefore hypothesise that the acquisition of such structures should lead to the enhancement of transfer. In this connection it is interesting to note a study by Clarke *et al.* (1967) in which training in categorisation produced more successful transfer than training in a difficult matching task.

Piaget's conception of operativity relates directly to the categorisation of input (classification) and its transformation (e.g., in seriation, transitivity). There is therefore considerable interest (a) in examining the unity of the concept of operativity and (b) in exploring the relations between operativity (i.e., intelligence as defined by Piaget) and learning as evidenced by achievement in scholastic tasks.

However, any attempt to produce a Piagetian scale of measurement as opposed to one based on Spearman must sacrifice some elements in Piaget's own position. In particular, while the clinical method is fruitful as a research tool, it is too unreliable and too subjective to be used as a psychometric device.

Also Piaget has frequently been criticised for his neglect of proper sampling procedures, and his own researches offer only the most general indications for comparing behaviour of children across different test procedures. At the same time Piagetian theory offers little support for pooling results from several ' tests ' to arrive at a combined ' operativity ' score. This is because the theory is predicated on the assumption of a limited number of discrete stages as opposed to a continuum which might correspond to IQ or MA. Nevertheless, a number of workers have compared children's performance on several tests (Carpenter, 1955; Smedslund, 1964; Laurendeau and Pinard, 1962; Tuddenham, 1968, 1969; Lunzer, 1970). In general one finds that correlations between tests are moderate rather than high, a fact which can hardly be surprising to anyone familiar with the theory and practice of mental measurement. Piagetian measures have also been used directly in comparing abilities of children raised in different cultural environments (Price-Williams, 1969; Vernon, 1969). Finally, there exists a small number of factorial studies designed to establish whether the abilities revealed in Piagetian situations constitute one factor or several, and whether such factor(s) are distinct from what is measured by conventional IQ procedures (Stephens *et al.*, 1972; DeVries, 1974). The result indicates the presence of more than one factor, conservation tasks being separate from the remainder, while these in turn coalesce into three or four ill-defined groupings, depending on the sample population and the precise measures used. Both Stephens and DeVries found at least one factor which loaded on IQ as well as on Piagetian tests, although the relevant tests were not the same. DeVries' sample was small (143 reduced to 50) and the age-range in Stephens' study was unduly large (6-18).

A number of authors have tried to establish a link between operativity as conceived by Piaget and capacity for short-term memory (McLaughlin, 1963) or information processing (Pascual-Leone, 1970), and these have been well reviewed in a paper by Halford (1968). Others (e.g., Braine and Shanks, 1965) have hypothesised that success in Piagetian tasks is largely a function of linguistic maturity, a view which has some affinities with Bruner's attempt to account for success in stages in intellectual functioning by reference to successive modes of representation : enactive, ikonic and symbolic (Bruner, *et al.*, 1966).

In the study to be reported an attempt was made to compare the performance of children on a group of Piagetian tasks with measures of language, learning, memory and intelligence. The sample is larger than those used in previous studies and homogeneous with respect to age. It was hypothesised that the Piagetian tasks should tap a distinct factor ' operativity,' defined as *the degree to which the subject can impose a coherent logical structure on input.* Previous work would seem to suggest that such a factor might emerge at the second-order level in an oblique rotation, while the first-order analysis would show conservation to be separate.

Since the battery included two tests of seriation, three classification items and two spatial measures, these might result in correlated factors at the first level of analysis. Of the two non-Piagetian mental tests, Raven's Matrices and Ilg and Ames' test of Figure Copying, it could be anticipated that the former should factor with other classificatory tasks, and the latter with the tasks of spatial co-ordination. If Piaget's theory is correct, operativity should appear as distinct from language. Equally one would not expect it to be closely dependent on STM, since operativity relates to the transformation of input rather than its mere retention.

METHOD

Sample.

Three local education authorities were selected in close proximity to the University of Nottingham, each authority having a wide cross-section of children coming from different home backgrounds. A total of 21 schools were chosen in consultation with inspectors in the three authorities in such a way as to provide seven schools in each of the categories: under-privileged, lower-middle and privileged.

Choice of subjects was restricted to children in the first year whose ages were in the range 5:6 to 6:0 at the time of selection.

Within these restrictions, five boys and five girls were chosen at random from each school, yielding a total sample size of 210.

Wherever possible, full details of parental occupation were obtained by means of personal interviews. Table 1 shows the numbers of pupils in each school group falling into three categories of parent occupations.

TABLE 1

Distribution of Pupils in Each School Group According to Parent Occupation

	Occupation Group 1	Occupation Group 2	Occupation Group 2	
	Professional and high administrative, managerial and executive, high grade non-manual and inspectorial	Lower grade inspectorial, skilled manual, routine non-manual	Semi-skilled manual, unskilled manual	Missing information
School Group 1	27	27	5	11
School Group 2	13	29	18	10
School Group 3	4	28	23	15
Total	44	84	46	36

Procedures.

All of the tests were administered on an individual basis by members of the research team, each of whom had developed a considerable expertise in his own area. So far as possible the order of tests was the same for the whole sample. To avoid undue fatigue, each session was limited to 10-20 minutes, which meant that each child was seen on 25-30 occasions.

Tests.

Full details of the tests used in the enquiry may be found in the research report to be submitted to the SSRC (Lunzer, 1976): following is a brief description grouped into five categories.

Operativity: A total of nine tests were derived more or less directly from the studies of Piaget and his associates (details of administration of these tests having been given in a preliminary form in an earlier study by Lunzer, 1970). The tests used were: conservation of number (1-1 correspondence), conservation of length, seriation of rods, multiple seriation, classification (correct use of ' all ' and ' some '), class-inclusion, intersection (child is required to place coloured shapes in the appropriate sector formed by two, or three overlapping hoops each of which should define a given colour, shape or thickness), linear and circular order (copying or reversing arrangements of beads on a string), and haptic perception. The majority of these tests are adaptations of the procedures used in a previous enquiry by Lunzer (1970). The procedure for multiple seriation was developed from a technique used by Mackay *et al.* (1970). The test of haptic recognition involved a considerable modification of procedure as compared with that used by Piaget and Inhelder (1956) so as to allow a more objective scoring, taking into account the separate confusions which a child can make or avoid, i.e., rectilinear *versus* curvilinear, number of edges, proportion of figure, size of angles, etc. (see Dolan, 1974, for a more detailed discussion).

Learning: Four of the tests used in this part of the battery were essentially measures of operativity, using a more structured procedure with deliberate cueing in the form of demonstration and correction. These were included with the idea of differentiating between the ability to impose a spontaneous ordering on the material provided and the ability to accept, to replicate, and to transfer a systematic categorisation when this is deliberately demonstrated or taught. These measures were (i) cross-classification: material to be classified first in one dimension (e.g. colour), and immediately following this by another (e.g., shape); two posting boxes were used to prevent a four-fold two dimensional classification which is relatively easy and misses the essential point, which is to ignore irrelevant criteria; (ii) transformation: again the material consisted of coloured shapes and the child was shown by means of examples how to ' transform ' colour while retaining shape and size, or to transform both shape and size while retaining colour, etc.; (iii) learning moves and equivalences in a six group—the group chosen was isomorphic with the rotations and reflections of a triangle, although the material was specially developed to be attractive and comprehensible to young children (a rotating platform with three animals occupying three 'stations'); (iv) learning a two-group: here trial and error is used to acquire a simple rule for choosing one of two objects to partner a third, viz, red light=' match,' green light=' alternate.'

A fifth test was more nearly a measure of rote learning using paired associates: linking geometrical shapes with drawings of familiar objects (child learns to guess the shape of the slot concealed by each of three drawings and selects the shape he will put in before exposing the slot). The sixth and final measure of learning was originally included as a test of LTM: the child is given 10 repetitions of a list of 10 unrelated words and is scored for accuracy in the last two presentations.

Language: The first two measures are well known standard tests, viz., the English Picture Vocabulary Tests (Brimer and Dunn, 1962) and the Crichton Vocabulary Scale. The first of these involves verbal production and recall (defining meanings of words) while the second involves recognition (selection of a picture from an array). The third test again involves production, being derived from the Watts Language Scale (1944) and requires description of a picture. The remaining two tests were of grammar. One was an adaptation of the comprehension section in the scale used by Fraser *et al.* (1963), and is a measure of the child's ability to identify the grammatical cues signalling passive voice, plural number, etc. To allow a greater accuracy of scoring, the procedure was altered by providing three multiple choice pictures rather than just two. The final measure focused on a single aspect of transformational grammar, viz., the ability to work through to an understanding of the deep structure of sentences having the form ' eager to bite ' or ' easy to bite ' and was based on the work of Cromer (1970).

Memory: In addition to the list-learning referred to earlier, the battery included four tests of STM and four of LTM. The former were: digit span and memory span for unrelated words, reproducing a sequence of animal pictures and reproducing a sequence of diagrams. The presentation of sequence was audial for the first two tests and visual for the second. Since memory for visual presentation is known to be facilitated by labelling (Flavell *et al.*, 1966), it should be noted that labelling was easier for the animal pictures than for the shapes. The interval between presentation and recall was one day for all LTM measures. Two of these were stories read to the child who was subsequently asked (*a*) to repeat the story and (*b*) to listen to a repetition and supply details in gaps. Each pair of scores was combined to yield a single score for free recall and another for cued recall. Two of the tests were designed to discriminate between memory for content and memory for structure (cf. Piaget and Inhelder, 1973). The first consisted of a cross-classification in a matrix arrangement (animals, vehicles, furniture, with one, two or four supports). The second was again a matrix presentation, but this time ordered in two senses (pictures of trees, seriated by colour and density of foliage). In this test the child was also asked to observe and reproduce a sequence of transpositions executed by the tester in such a way as to preserve the ordering. The scores for these two tests were not combined in the analysis of data. The last memory test was again a test of visual recall, the child being asked to name as many as he could of 12 familiar objects following a 60-second presentation.

Standard tests of intelligence: In addition to the Crichton Vocabulary Scale, the battery included two additional tests: Raven's Progressive Matrices (coloured version, 1961) and Ilg and Ames' test of figure copying (1964).

Scoring.

Standard procedures were developed for administering all of the above tests, including detailed instructions for scoring. With the exception of the memory measures described in the last paragraph, each test yielded a single score. For the most part there was a satisfactory distribution of scores, with discrimination right across the ability range. The one notable exception was the third test of learning, structure of a six-group, which proved too difficult for most of the children.

RESULTS

Reliability.

Table 2 provides details of reliability for each of the 34 measures. Where the reliability could not be obtained using one of the standard methods (test-retest, split-half) the highest within-group correlation was taken as the next best estimate.

Allowing for the shortness of the Piagetian measures, intercorrelations of the order of ·5 to ·6 indicate an acceptable level of reliability. The value of ·86 obtained from test-retest on the haptic recognition may represent a nearer approximation to their true value. Three of the four STM tests have high reliabilities, as do the majority of the language measures. Measures of LTM and learning show only moderate reliability. One of the former and two of the latter have been omitted from subsequent calculations.

TABLE 2

HIGHEST CORRELATION AS RELIABILITY INDICATOR.

Test	Highest Correlation	With Test	Additional index and method
1. Cons. Length	·59	2	
2. Cons. Number	·59	1	
3. Seriation	·61	4	
4. Mul. Seriation	·61	3	
5. All and Some	·49	4	
6. Class Inc.	·42	7	
7. Intersection	·60	3	
8. Lin. and Circ.	·56	4	
9. Haptic Rec.	·54	4	·86 TR (N=20)
10. Cross Classification	·45	4	·46 TR (N=18)
11. Transformation	·53	4	·77 SH (N=21)
12. 2-group Lng.	·49	14	
13. Grammar	·49	17	
14. Deep Structure	·55	17	
15. Watts	·56	16	
16. E.P.V.T.	·70	17	
17. Crichton	·70	16	
18. STM Digits	·65	19	·80 TR (N=20)
19. STM Words	·65	18	·72 TR (N=20)
20. STM Shapes	·46	21	·70 TR (N=20)
21. STM Animals	·46	20	·48 TR (N=20)
22. List Learning	·48	24	
23. Story Recall	·46	17	·80 SH (N=200)
24. Story Cued Recall	·51	17	
25. Kim's Game	·27	24	
25. LTM Ser'n Content	·40	12	
27. LTM Ser'n Structure	·41	29	
28. LTM Matrix Content	·33	26	
29. LTM Matrix Structure	·41	27	
30. Raven's Matrices	·45	7	·58 TR (N=129)
31. Ilg and Ames	·58	4	
Measures not included in factor analysis			
Six group learning	·50	7	·94 TR (N=21)
PA learning	·37	9	
LTM Matrix (transposition)	·36	7	

TR = test-re-test SH = split half

TABLE 3

LEVELS OF CORRELATION BETWEEN COGNITIVE MEASURES.

Tests of	Operativity	Language	Learning	Memory
Operativity	17, 28, 39, 17	36, 39, 25, 0	51, 20, 27, 2	86, 14, 0, 0
Language		0, 50, 16, 34	45, 45, 10, 0	76, 20, 4, 0
Learning			50, 40, 10, 0	78, 22, 0, 0
Memory				67, 19, 9, 4

Rows and columns correspond to groups of scores derived from Piaget tests (9), Language (5) Learning (5) and Memory (13)
The four figures in each cell represent the percentage of Z values in the range:
0—·29, ·30—·39, ·40—·49, and ·50 and over

Level of correlation between tests.

Table 3 gives a summary of the level of correlations found between the several scores yielded by the battery. It will be seen that these are moderate rather than high, the majority being in the ranges ·30 to ·39 and ·40 to ·49. Correlations within groups of related tests are somewhat higher than correlations between tests in different groups, but this is by no means invariable. Despite the high reliability of many of the measures of STM they rarely yield correlations of the same magnitude as operativity and language tests. Correlations between operativity and learning tend to be somewhat higher than those between learning and language, as is to be expected from the design of several of these measures. The reverse is the case for the tests of memory.

TABLE 4

FACTOR LOADINGS FROM OBLIQUE ROTATION OF A PRINCIPAL COMPONENTS ANALYSIS.

	Factor and Sample											
	I			II			III			IV		
Tests	All	B	G	All	B	G	All	B	G	All	B	G
Cons. Length	00			01			−09			−02		
Cons. Number	−02			06			02			−06		
Seriation	75*	+	+	−12			−15			02		
Mul. Seriation	85*	+	+	−04			03			−05		
All and Some	52*		+	16			03			05		
Class Inc.	06			−05			10			26	+	+
Intersection	46*	+	+	10			02			−04		
Lin. and Circ.	60*	+	+	−18			05			10		
Haptic Rec.	46	+	+	11			04			21		
Cross Classification	33	+		10			17		+	02		
Transformation	82*	+	+	−01			−04			−08		
2-Group Lng.	45*	+		23			12			−03		
Grammar	−14			53*	+	+	09			11		
Deep Structure	15			58*	+	+	01			−20		
Watts	22		+	56*	+	+	−07			03		
E.P.V.T.	−05			84*	+	+	00			−09		
Crichton	−06			73*	+	+	−08			15	+	
STM Digits	00			−04			02			07		
STM Words	−02			06			−04			−04		
STM Shapes	−09			−18			03			33*		
STM Animals	−05			07			15			14		
List Learning	00			−05			−01			46*	+	+
Story Recall	02			−08			−10			72*	+	+
Story Cued Recall	−04			09			−02			74*	+	+
Kim's Game	−15			08			17			31*	+	+
LTM Ser'n Content	09			−08			78*	+	+	00		
LTM Ser'n Structure	−11			02			70*	+	+	−06		
LTM Matrix Content	−14			18			40*	+	+	15	+	
LTM Matrix Structure	−03			09			41*	+	+	05		
Raven's Matrices	19			10			00			07		
Ilg and Ames	38*	+		−06			−08			10		
% Contribution	29·15	30·9	17·6	21·05	25·5	19·8	15·39	13·4	16·9	12·30	8·7	14·2

*indicates salients + and — indicate direction of salients for analyses separately by sex

TABLE 4—*continued*

Tests	Factor and Sample								
	V			VI			VII		
	All	B	G	All	B	G	All	B	G
Cons. Length	64*	+	+	01			−08		
Cons. Number	71*	+	+	−05			05		
Seriation	14			−02			10		
Mul. Seriation	−03			−01			−03		
All and Some	−15			02			−05		
Class Inc.	21	+	+	13	+		−21*	−	−
Intersection	24*	+	+	04			01		
Lin. and Circ.	11		+	09			−09		
Haptic Rec.	−11			04			−10		
Cross Classification	−09			11			−11		
Transformation	−14			−08	−		06		
2-Group Lng	−17			−09	−		21*	+	
Grammar	05			08			−18*		
Deep Structure	−01			−02			19*	+	
Watts	−16	+		04			−08		
E.P.V.T.	03			01			02		
Crichton	06	+		−01			−01		
STM Digits	−03			73*	+	+	03		
STM Words	−02			68*	+	+	03		
STM Shapes	12			15			28*	+	+
STM Animals	07			10			35*	+	+
List Learning	00			27*	+	+	00		
Story Recall	01			−11			13*		
Story Cued Recall	−11			−08			−04		
Kim's Game	15			−02			−03		
LTM Ser'n Content	−08			−03			00		
LTM Ser'n Structure	07			02			03	−	−
LTM Matrix Content	00			−07			−15		
LTM Matrix Structure	02			−01			04		
Raven's Matrices	24*			−05			−01		
Ilg and Ames	21			04			−05	−	+
% contribution	10·10	13·6	8·8	8·96	11·7	6·9	3·04	6·7	5·3

*indicates salients + and − indicate direction of salients for analyses separately by sex

TABLE 5

FIRST-ORDER FACTOR CORRELATIONS AND LOADINGS ON SECOND-ORDER FACTORS

	II	III	IV	V	VI	VII	I′	II′
I Operativity	·778	·620	·605	·745	·424	·261	·12	·77*
II Language		·486	·829	·620	·590	·455	·59*	·31
III LTM Visual			·519	·315	·638	·336	·40	·22*
IV LTM Verbal				·454	·648	·492	·85*	−·01
V Conservation					·283	·157	−·25	·95*
VI STM Verbal						·489	·85*	−·20
VII STM Visual							·88*	−·43

(r between I′ and II′ is ·85)

Factor Analysis.

The principal data from the various factor analytic procedures used are shown in Tables 4 and 5. Table 4 is based on oblique solution of the matrix, using Kaiser's " Second Generation Little Jiffy " (1970). A preliminary principal components analysis yielded seven factors having eigen values greater than unity. The seven columns of figures show the test loadings on rotated factors for the correlation matrix based on the whole sample. Asterisks are ' salients ' for interpretation. Against each of these columns the table shows all the salients yielded by similar analysis applied to correlation matrices based on the two sexes taken separately. To avoid cluttering the table, only salients are shown for these analyses, and they are indicated only by direction (+or —ve). It will be seen that all seven factors are clearly interpretable and that they are reproduced with only minor variation when the sexes are taken separately. Factor I is an operativity factor, II is language, III is either memory for logical arrangement or visual LTM, IV is verbal memory, V is conservation, VI is STM for audial presentation and VII has its highest loadings from the STM visual tests.

It should be pointed out that the factor structure is not the result of chance, since it reappears for each of the sexes. Nor is it due only to the particular mode of rotation. The same seven factors appeared with almost equal clarity in the varimax solution. The oblique solution has the advantage that it is sharper (there being more high loadings and also more near-zero loadings on each factor), and that it is probably more faithful to the psychological reality (one would expect the several aspects of cognitive ability to be correlated). It has the further advantage that the relations of the matrix can be further explored by examining the correlations between factors, as has been done in Table 5. Despite the very high correlation between Factors I′ and II′ (·85) they give two distinct second-order factors, again corresponding to the verbal/symbolic aspect and the operative aspect of cognitive functioning. One notes that the principal contributions to the latter are Factor I and Factor V (conservation). No less noteworthy, however is the fact that all of the memory factors have substantial contributions to the first second-order factor, and these are invariably greater than their loadings on II′ (the operative aspect).

Effect of sex and socio-economic status.

Table 6 gives a summary description of the effects of sex and socio-economic grouping on the distribution of scores on each of the variables used in the enquiry. The first six columns show the mean standard scores for each of the six sub-groups. These give an indication of their deviation from the means obtained from all children in socio-economic group II, set at 100 in all cases, in terms of a common standard deviation of 15. It will be recalled that the intermediate group had been randomly selected from a large group of schools that were neither privileged nor disadvantaged. Columns 7 and 9 show the F-ratios corresponding to these differences as yielded by separate two-way analyses of variance. The ratios in column 8 were completed not from school groups but from parent occupation. It will be seen that while sex differences were generally negligible (girls were superior in tests 6, 8, 11 and 18, boys surprisingly in 16, EPVT), there were marked social class differences for nearly all measures of operativity as well as for language. The smallest differences occur mainly in the memory tests. Here, however, it may be noted that differences are more significant when the grouping is by parental occupation as opposed to school catchment area.

TABLE 6

STANDARD SCORES AND F-RATIOS FOR THE SOCIO-ECONOMIC GROUPS

							F Ratio		
	Upper SEG		Middle SEG		Lower SEG		SES school group	SES parent group	Sex
	boys	girls	boys	girls	boys	girls			
Cons. length	114	106	100	100	94	92	4·6*	1·9	1·3
Cons. number	109	104	100	100	99	99	6·2**	1·8	0·4
Seriation	108	112	99	101	96	94	19·9**	7·0**	0·4
Mult. Seriation	108	108	100	100	96	94	14·4**	8·0**	0·4
All and Some	104	107	102	98	90	91	23·3**	16·0**	0·0
Class Inclusion	98	103	98	102	94	99	2·1	2·5	6·8*
Intersection	106	101	101	99	91	94	10·3**	7·7**	0·3
Lin. and Circ. Ord. ...	102	106	97	103	93	97	6·5**	5·9**	5·8*
Haptic Recog.	106	106	102	98	95	93	9·9**	7·7**	0·4
Cross Classification ...	100	102	99	101	93	100	1·6	7·1**	3·2
Transformation.......	103	109	99	101	90	98	10·3**	6·3**	6·3*
Two Group Lng.	107	102	99	101	91	96	8·9**	16·0**	0·3
Grammar	96	99	98	102	91	92	6·2**	3·3*	1·8
Deep Structure	106	101	98	102	96	97	3·8*	9·7**	0·0
Watts	106	106	99	101	91	94	14·2**	7·3**	0·5
E.P.V.T.	109	103	103	97	94	89	17·5**	26·5**	7·1**
Crichton.............	107	101	100	100	91	87	17·5**	20·9**	2·3
STM Digits	99	102	95	105	95	98	1·3	1·0	6·2*
STM Words	99	101	95	105	93	95	2·5	4·8**	3·0
STM Shapes	96	101	98	102	99	96	0·4	2·9	0·8
STM Animals	101	100	99	101	93	96	3·8*	11·2**	0·4
List Learning	99	101	99	101	96	96	3·5*	7·1**	0·5
Story Recall	99	103	102	98	96	94	3·6*	5·0**	1·3
Kim's Game	97	93	97	103	95	90	4·0*	5·3**	0·1
LTM Ser'n. Content ..	100	101	98	102	93	96	3·4*	6·8**	1·5
LTM Ser'n. Structure	99	100	99	101	96	98	1·3	7·7**	0·3
LTM Matrix Content	97	99	97	103	95	94	2·6	3·8*	1·1
LTM Matrix Structure	98	100	98	102	89	93	6·7**	2·6	1·8
Raven's Matrices	106	101	101	99	96	99	3·1*	3·5*	2·3
Ilg and Ames	108	108	99	101	97	97	11·0**	9·6**	2·1

*P<0·05 **P<0·01

Differences in the strengths of correlations by social class.

The 32 tests yielded a total of 561 intercorrelations for each socio-economic group, and it was noted that these relationships tended to be highest in the lowest socio-economic group. This trend is borne out by the analysis in Table 7. In each block, the first two rows show frequencies of test-pairs where the difference between the strength of correlation in the two groups is substantial (P< ·20) and in brackets, significant (P< ·05)—following Guilford (1954). In each of the three blocks the figures in the second row exceed those in the first row. This trend cannot be accounted for by a tendency for higher variance to be associated with lower socio-economic groups. Comparisons of correlations between test pairs have been separated according to whether the larger variance of both tests is found in the same socio-economic group (columns 1 and 3), or not (column

2). While there is an overall tendency for higher variance to go with lower socio-economic group (frequencies in column 3 tend to exceed those in column 1), differences in correlational strength are independent of this (frequencies in the second row exceed those in the first row in all three columns).

TABLE 7

DIFFERENCES IN VARIANCES AND STRENGTH OF INTERCORRELATION OF MEASURES IN THREE S.E. GROUPS.

Groups	Direction of Difference in Correlation	Comparison of Variances		
		HH	HL	LL
1+2	$r_1>r_2$	16 (2)	33 (0)	15 (0)
	$r_2>r_1$	30 (3)	78 (11)	40 (6)
	$r_1 \bumpeq r_2$	74	177	98
	Total	120	288	153
1+3	$r_1>r_3$	7 (0)	16 (0)	10 (1)
	$r_3>r_1$	25 (1)	111 (18)	92 (32)
	$r_1 \bumpeq r_3$	46	146	108 (8)
	Total	78	273	210
2+3	$r_2>r_3$	7 (0)	32 (1)	29 (3)
	$r_3>r_2$	23 (2)	74 (12)	71 (15)
	$r_2 \bumpeq r_3$	36	158	131
	Total	66	264	231

HH = Both variances in higher SE group exceed corresponding variances in lower SE group
LL = Both variances in lower SE group exceed corresponding variances in higher SE group
HL = One variance in higher SE group exceeds corresponding variance in the lower SE group, this order being reversed for the other variable.

DISCUSSION

Taken as a whole the enquiry was designed to illuminate the contribution of measures derived from the theory of Piaget to the evaluation and prediction of cognitive behaviour. Within this perspective the present paper is concerned with two problems: (i) the factorial identification of operativity and its relation to language and memory and (ii) to establish which of the measures used in the study are least sensitive to individual differences associated with socio-economic status and which are most sensitive to such differences.

The data support the view that there is a distinct factor of operativity in children of this age-group. Of the Piagetian tests as well as the related tests of conceptual learning, a substantial number have significant loadings on Factor I. This factor therefore emerges as the principal operativity factor, the heaviest contributions being drawn from the tests of seriation and multiple seriation. The two conservation tests loaded on a separate factor, which is not altogether surprising since the succession of events and the questions in any two conservation tests will always be fairly similar. There are also built-in similarities in the structure of the variables involved: every conservation experiment involves a preliminary defining situation, followed by a transposition which leads to disparate observations on two non-critical but compensating dimensions. Both Tuddenham (1969, p. 66) and Vernon (1969, p. 140) found correlations between different measures of conservation exceeded correlations between conservation and other messures of operativity. However, both these factors collapse on Factor II, as the second-order level. The majority of the measures concerned have satisfactorily high reliabilities (Table 1). Thus it appears that operativity can be reliably measured in children of this age, using a relatively small number of well-chosen procedures.

The factorial composition of operativity appears to be distinct from that of language behaviour. On the other hand, it is interesting to note the absence of any clear differentiation between comprehension and production or between grammar and lexis, despite the deliberate inclusion of distinct procedures for these several aspects of language behaviour.

It should be noted that although language and operativity remain factorially distinct even at the second-order level, these factors are oblique and quite strongly correlated with each other. Correlations between factors tend to be higher than correlations between tests because of the elimination of variance that is specific to one measure, including a great deal of the error variance. The basis for the differentiation between language and operativity will be considered in a second paper after taking into account their contribution to the prediction of reading and mathematics.

Memory produces four distinct factors, corresponding to the four groups of tests, perhaps the most interesting finding being the sharp differentiation of STM depending on the modality of input. Measures of STM, like those of LTM, correlate more strongly with language than with operativity. While correlations between memory and operativity are positive (Table 3), their modal value is in the ·1 to ·2 range, several are near zero and even the highest do not reach the value of ·3. Moreover, LTM measures correlate more highly with operativity than do STM (words) and (digits) or, for that matter, STM (animals) and (shapes). Thus, the present data give little support to the view of McLaughlin (1963) which seeks to explain the development of operativity by reference to increases in STM span. Clearly, it would be impossible to contend that operativity is independent of memory span. Since the judgments that are taken to characterise an operational level invariably involve selection among cues and a balancing of opposing evidence, the quasi-simultaneous availability of such evidence for reflection must figure as a pre-condition for operativity. One may conclude that the the present data are not inconsistent with the White-Jensen view that STM is a lower-level process, as it does not involve (controlled) transformation of input (White, 1965; Jensen, 1970). Operativity points to a higher-order process which acts on the output of representation even though it may be itself available to representation.

Finally, it is clear that the Piagetian measures are highly sensitive to socio-economic group differences. Also, it appears that there is an inverse relationship between socio-economic status and the magnitude of within-group correlations. Correlations are higher in the disadvantaged group than in the privileged group. Perhaps the simplest interpretation of this phenomenon is that of developmental differentiation—that the higher socio-economic groups are more mature, and that the operative and symbolic components of cognition are progressively differentiated as a function of use. However, a direct test of this interpretation would require repeated testing of the same children.

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THE EFFECTIVENESS OF MEASURES OF OPERATIVITY, LANGUAGE AND SHORT-TERM MEMORY IN THE PREDICTION OF READING AND MATHEMATICAL UNDERSTANDING

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SUMMARY. Tests of reading and mathematical understanding were administered to 210 children from three socio-economic backgrounds who had been tested 12 months earlier during their first year at school. When first seen, the children were given 28 cognitive tests, the results of which have been discussed in a previous paper (Lunzer, *et al.*, 1976). Measures of operativity were found to be superior to measures of language in predicting progress in mathematics for all socio-economic groups. Operativity was also superior for socio-economic Groups 1 and 3 in predicting success in reading of unrelated words, and was comparable with language in the case of Group 2. Operativity and language were found to have similar powers in the prediction of reading comprehension. Short-term memory for the presentation of a visual sequence proved to be a highly significant and independent predictor for success in word recognition and, to a lesser degree, in mathematical understanding.

INTRODUCTION

THE present paper is concerned with a follow-up study based on an investigation of cognitive competence in a sample of 210 children aged 5:6 to 6:0 when first seen in 1971-72. In a previous paper (Lunzer *et al.*, 1976), it was shown that measures derived more or less directly from Piagetian theory yielded a distinct factor of operativity as well as a separate factor of conservation. While there was a high correlation between the two Piagetian factors and a factor loading on language, the two aspects remained differentiated at the second-order level. Four additional first-order factors were found, each corresponding to a distinct group of memory tests. In general, these merged with the language factor at the second-order level.

In the course of a further investigation carried out in 1972-73, measures of scholastic progress of the sample were obtained using a variety of tests of reading and mathematical understanding. Taken together, the two sets of data permit one to assess the usefulness of Piagetian testing as a predictor of school learning.

A recent study by Ralph Scott indicates that a simple measure of seriation predicted reading with greater accuracy than any of the other tests in the Metropolitan Reading Readiness Tests (Scott, 1970). The work of Scott was not familiar to the writers at the time of the present study. There do not appear to be any other studies directly relating Piagetian measures to reading or mathematics, although a number of factorial studies have included both types of variable within the same analyses (Vernon, 1969; Stephens *et al.*, 1972; DeVries, 1974). Recent writings on the subject of deprivation have tended to emphasise language as the key to intellectual progress (Bernstein 1961, 1971; Hess and Shipman, 1972). It is true that most of the structured intervention programmes reviewed by Beller (1973) include concept training as well as language training and the methods developed by Blank and Solomon (1968) used language training itself as a vehicle for concept training. However, a number of programmes reveal an almost exclusive concern with language enrichment to counter scholastic deficit (Gray and Klaus, 1970; Gahagan and Gahagan, 1970).

While it is possible that language deprivation is at the root of such cognitive deficit as is associated with low socio-economic status, there are at least two other possibilities. One is that known differences in language environment between social classes also imply differences in intellectual stimulation and in particular in the encouragement to classify, to order and to synthesise information, and it is the latter which is critical and not the language itself. Alternatively, one might well hold that such differences are at least in part a reflection of differences in genetic endowment of the parents themselves (Jensen, 1970). The present enquiry is directed to the first alternative rather than the second.

In what follows, the findings of the original study, based on the results of 28 measures of cognition, will be referred to as those of Year One. No measures of attainment were taken in Year One as the children had been at school less than six months. However, a follow-up study which was carried out the following year (Year Two) concentrated on attainment in reading and mathematics. Measures were chosen to cover mechanical reading, reading comprehension and mathematical understanding.

Since reading is a language skill whilst mathematics is closely connected to logic, it was hypothesised, perhaps a little naively, that language would be a better predictor of reading while the operativity measures would be superior in predicting mathematical understanding.

METHOD

Sample.

The sample consisted of the 210 children seen in Year One less a few who were not available for testing the following year. Of the original sample, 70 were representative of privileged school catchment areas (socio-economic group 1) and 70 of under-privileged areas (group 3), the remainder being intermediate (group 2). There were equal numbers of boys and girls. When tested in Year Two, they were aged 6:6 to 7:0, having been at school for 1½ years. After allowing for absences and transfers to other schools, approximately 60 children in each group were available for this part of the enquiry, yielding a total of 183 (reading test) and 184 (mathematics test).

Tests.

Criterion measures.

A graded word reading test (Schonell, 1942) was adopted as the main index of mechanical reading efficiency. Two other measures were taken, namely, Test One of the Standard Diagnostic Reading Tests (Daniels and Diack, 1958) and the Neale Analysis of Reading Ability (Neale, 1966). The first of these uses sentences and the second features whole paragraphs. It was anticipated that either might furnish a less crude index of reading ability than the Schonell test which involves reading unrelated words. In the event, intercorrelations of the three tests ranged between ·946 and ·954. There was therefore no advantage in using the results of these other procedures. However, the Neale test affords separate scores for comprehension. These were taken as the second criterion measure.

Since no satisfactory mathematics test could be found, a test of mathematical understanding (see Appendix) was specially constructed, focusing on the conceptualisation of simple numerical and geometric relationships. It was not a test of logic, nor did it include items such as seriation and classification, as it would have been circular to use Piagetian measures to predict success in solving problems directly derived from Piaget.

Predictor measures.

28 measures were administered in Year One to yield 34 scores. These were described in some detail in the previous paper and are fully documented by Lunzer (1976). However, the following is a brief indication of the kinds of measures used:

(i) nine tests more or less directly adapted from the work of Piaget, including measures of conservation, of classification and of seriation;
(ii) three measures of conceptual learning, of which two were closely akin to Piagetian measures but included a more significant element of cueing and feedback (cross-classification and transformation of one or more attributes in geometrical shapes);
(iii) five measures of language, including the Crichton Vocabulary Scale;
(iv) four measures of short-term memory;
(v) recall of story material (two stories) and of objects on a tray;
(vi) recall of matrix arrangements as measures of memory for structure (cf. Piaget and Inhelder, 1973) (three scorable responses);
(vii) two recognised tests of non-verbal intelligence (Raven's Matrices and Ilg and Ames Figure Copying Test).

Procedure.

All children were individually tested at their own schools by full-time students at the university, all qualified and experienced teachers on either Diploma in Education or Master of Education courses.

Treatment of Data.

To facilitate the analysis and interpretation of results, it was decided to pool some of the Year One predictor variables on the basis of the factor analysis reported in the previous paper. Accordingly, the scores of certain measures were averaged whilst others of lesser interest were omitted to yield seven pooled predictor variables, corresponding to the seven factors derived from the original data. The groupings of variables was as follows:

Conservation: Average of conservation of number and of length.

Operativity: Average of six Piagetian tests together with two tests of conceptual learning (classification and transformation).

Language: Average of five tests of linguistic competence, including the EPVT and Crichton Vocabulary Scale.

STM (auditory): Average of STM (digits) and STM (words).

STM (visual): Average of two tests (sequential reproduction of animal pictures and of shapes).

Story recall: Average derived from spontaneous and cued recall of the two separate stories.

Memory for system: Average score gained from four measures yielded by recall of two presentations of well ordered two-dimensional matrix arrangements (classificatory and seriatory).

All of the multiple regression calculations to be reported were devised from the program REGRAN given by Veldman (1967). The program is admirably suited to the task of evaluating the relative contributions of a number of predictors by comparing alternative 'models.'

The basic technique consists in first computing the best prediction using all of the predictors and then testing the effect of omitting one or more variables from the predictor set. The significance of any reduction may be tested against the reference model by analysing its effect on the squared multiple correlation and computing an F-ratio.

RESULTS

Differences in scores according to socio-economic grouping.

In order to permit of the averaging referred to in the previous section, all of the scores obtained in Year One were converted to a common mean of 50 with a standard deviation of 10. Table 1 shows the means and standard deviations for each of the seven predictor variables and the three criterion tests both for the group as a whole and for each of the three sub-groups. Because of the regression effect, variables based on the averaging of several scores tend to have a reduced standard deviation.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR THE GROUP AS A WHOLE AND FOR THE THREE SOCIO-ECONOMIC GROUPS ON PREDICTOR AND CRITERION MEASURES.

	All		Seg 1		Seg 2		Seg 3		Between-group differences		
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	1 v 2	2 v 3	1 v 3
Predictor	50·37	9·25	53·28	10·46	48·91	7·33	49·00	8·61	*		**
Conservation	50·13	7·25	53·67	5·81	50·21	6·75	46·09	7·05	*	**	**
Operativity	49·94	7·80	52·89	6·20	50·72	6·72	45·92	8·62		**	**
Language	49·78	9·19	51·12	8·61	50·00	8·32	48·06	10·72			
STM Auditory	49·90	8·55	50·69	7·82	51·01	8·77	47·95	8·79			
STM Visual	49·82	8·97	51·30	8·23	51·12	9·95	46·93	8·04		*	*
Story Recall											
Mem. for System	49·98	7·59	51·01	7·74	51·21	6·23	47·66	8·06		*	*
Criterion											
Schonell Wd. Rec.	14·52	14·03	18·75	14·26	15·77	16·30	8·49	8·02		**	**
Neale Comp'sion	7·13	6·80	7·67	4·45	8·84	9·97	4·88	4·18		**	*
Mathematics	16·69	6·25	18·42	5·60	17·24	5·69	14·28	6·66		*	**

$^{**}P < \cdot 01$ $^{*}P < \cdot 05$

Group differences for the scores that make up the predictor variables have been described in the previous paper. It may be noted that the performance of socio-economic group 3 is inferior to that of both the remaining groups except in conservation, and that the highest socio-economic group achieves markedly superior means for the first three predictors (conservation, operativity and language).

Both the Schonell Word Recognition test and the mathematics test show marked social class effects, especially as between groups 2 and 3. The Neale Test of Comprehension yielded the highest mean in group 2, but this was combined with a higher standard deviation, indicating a lesser homogeneity.

Correlations of predictor variables of Year One with attainment measures of Year Two.

Correlations between predictor variables are shown in Table 2. They add little to the discussion of the previous paper but assist interpretation of analyses in the present one. Predictor-criterion correlations are shown in Table 3 both for the sample as a whole and for the three socio-economic groups taken separately.

TABLE 2

INTERCORRELATIONS OF THE POOLED COGNITIVE MEASURES.

	1	2	3	4	5	6	7
1 Conservation	—						
2 Operativity	·47	—					
3 Language	·38	·66	—				
4 STM Auditory	·09	·38	·37	—			
5 STM Visual	·17	·37	·43	·38	—		
6 Story Recall	·16	·41	·50	·27	·44	—	
7 Mem. for System	·15	·50	·36	·24	·31	·29	—

TABLE 3

CORRELATIONS OF PREDICTOR MEASURES IN YEAR ONE WITH CRITERION MEASURES IN YEAR TWO.

	Schonell Word Recognition				Neale Comprehension				Mathematical Understanding			
	All	Seg 1	Seg 2	Seg 3	All	Seg 1	Seg 2	Seg 3	All	Seg 1	Seg 2	Seg 3
Conservation	·31	·27	·22	·44	·17	·25	·07	·31	·48	·42	·48	·50
Operativity	·57	·52	·48	·68	·38	·53	·21	·59	·71	·70	·65	·69
Language	·49	·41	·46	·54	·37	·44	·21	·59	·62	·50	·57	·64
STM Auditory	·32	·29	·37	·26	·30	·35	·31	·30	·36	·22	·29	·46
STM Visual	·47	·40	·55	·45	·43	·33	·49	·44	·40	·17	·41	·51
Story Recall	·25	·12	·20	·35	·43	·43	·39	·50	·38	·19	·34	·51
Mem. for System	·33	·28	·30	·37	·23	·23	·14	·34	·33	·21	·33	·34
N	184	67	57	60	184	67	57	60	183	65	58	60

The data of Table 3 may be summarised as follows:

(1) In general, the compound measure of operativity yields higher correlations with both Schonell Reading and Mathematical Understanding than any other single predictor variable.

(2) Language is generally speaking the second best predictor, but correlations with criterion variables are uniformly lower than those yielded by operativity, save for the prediction of comprehension, when the two are equal.

(3) When the criterion is comprehension on the Neale test of reading, the strongest predictors are STM (visual) and story recall.

(4) STM (visual) proves to be the third best predictor for word recognition, and also yields high correlations for the remaining criteria.

(5) Conservation contributes to the prediction of mathematics, but not of reading.

(6) The data for socio-economic group 2 are somewhat anomalous especially in regard to the very high discrimination yielded by STM (visual).

(7) Correlations between predictor and criterion variables are higher in socio-economic group 3 than in group 2, and they are least in group 1.

Prediction of attainment based on cognitive measures taken in Year One.

Table 4 presents a convenient summary of the relative predictive power of each of the seven predictor variables with respect to each of the three criteria. In each of the three tables, the data in the topmost line are based on the complete model, including all seven predictors, while the remaining lines illustrate the effect of removing one or more of these. The values shown in the body of the table are correlations between the given (column) predictor and the *predicted* score based on the multiple R. Unlike B-weights, these values are undiminished by the strength of correlation between competing predictors. For comparison, correlations in the bottom row of each table are between predictor and *obtained* score, as in Table 3.

The overall R for Word Recognition is ·65. This is significantly reduced to ·607 when operativity is dropped from the predictor set and ·593 when both Piagetian predictors are omitted. Omission of language produced a non-significant reduction. Even when story recall (closely related to language) is also omitted, the combined R remains as high as ·636. STM (visual) contributes significantly to the prediction and its omission brings about a reduction of R to ·601. Conservation and STM (auditory) contribute not at all. It should, however, be said that the data for socio-economic group 2 are anomalous in that the only significant reduction results from the omission of STM (visual).

For Neale Comprehension, the overall R is ·539. Although the omission of language does not lead to a significant reduction in R, there are significant reductions following the omission of STM (visual) and story recall (R= ·503). Omission of operativity produces a smaller reduction of R, which is nevertheless significant at the ·05 level for groups 1 and 3.

For Mathematical Understanding, the overall R is ·757. This drops to ·701 with the omission of operativity. However, the omission of language also produces a small but significant reduction, to ·745. None of the measures of memory was found to contribute significantly to the prediction of this criterion.

TABLE 4

REGRESSION ANALYSIS PREDICTING ATTAINMENT IN READING AND MATHEMATICS IN YEAR TWO FROM COGNITIVE MEASURES GIVEN IN YEAR ONE FOR THE ENTIRE GROUP AND FOR THE THREE SOCIO-ECONOMIC GROUPS TAKEN SEPARATELY.

		Predictors									Seg 1	Seg 2	Seg 3
	Model	Cons	Op	Lang	Stm Aud	Stm Vis	Story Rec	Mem for System	Mult R	Cov	Cov	Cov	Cov
Schonell	1	·48	·87	·75	·49	·72	·38	·51	·650	—	—	—	—
	2	—	·88	·76	·49	·73	·38	·51	·649				
	3	·51	—	·81	·53	·78	·41	·55	·607	**	**		**
	4	·49	·89	—	·50	·73	·38	·52	·642				
	5	·48	·88	·76	—	·73	·38	·51	·649				
	6	·52	·96	·82	·53	—	·41	·55	·601	**	**	**	
	7	·49	·89	·77	·50	·74	—	·52	·641				
	8	·48	·87	·76	·49	·73	·38	—	·650				
	9	—	—	·83	·54	·80	·42	·60	·593	**	**		**
	10	·49	·89	—	·50	·73	—	·52	·636				
		·31	·57	·49	·32	·47	·25	·33	correlation with Schonell				
									N	184	67	57	60
Neale	1	·31	·71	·69	·55	·80	·80	·43	·539	—	—	—	—
	2	—	·71	·69	·55	·80	·80	·43	·539				
	3	·32	—	·70	·56	·81	·81	·43	·529		*		*
	4	·31	·71	—	·55	·80	·80	·43	·538				
	5	·32	·71	·69	—	·81	·80	·43	·534				
	6	·34	·76	·74	·59	—	·85	·46	·503	**		*	
	7	·34	·76	·74	·59	·85	—	·46	·503	**			
	8	·31	·71	·69	·55	·80	·80	—	·539				
	9	—	—	·70	·57	·82	·81	·44	·527		*		
	10	·34	·77	—	·60	·86	—	·47	·498	**			*
		·17	·38	·37	·30	·43	·43	·23	correlation with Neale Comp.				
									N	184	67	57	60
Mathematics	1	·63	·93	·82	·48	·52	·50	·43	·757	—	—	—	—
	2	—	·95	·84	·48	·53	·51	·44	·743	**		*	
	3	·68	—	·89	·51	·56	·54	·47	·701	**	**	*	*
	4	·64	·95	—	·48	·53	·51	·44	·745	**			
	5	·63	·94	·82	—	·52	·51	·43	·754				
	6	·63	·94	·83	·48	—	·51	·43	·753				
	7	·63	·93	·82	·48	·52	—	·43	·756				
	8	·63	·94	·82	·48	·52	·50	—	·756				
	9	—	—	·95	·55	·61	·59	·50	·651	**	**	**	**
	10	·64	·95	—	·49	·53	—	·44	·742	**			
		·48	·71	·62	·36	·40	·38	·33	correlation with Mathematics				
									N	183	65	58	60

NOTES:

(a) Values beneath predictors are correlations with the predicted score for the entire sample.
(b) MULT R is multiple correlation coefficient.
(c) COV is significance of covariance F-test for the effect of dropping the missing predictor from the full model.
(d) **P< ·01, *P< ·05.
(e) Correlation coefficients below the regression analyses refer to the relationship between predictors and criterion scores.

DISCUSSION

The principal question to which this paper has been addressed concerns the relative efficiency of Piagetian measures (measures of operativity) and of language measures in predicting progress that young children will make in acquiring the basic skills of reading and mathematics. The results are sufficiently clear: measures of operativity constitute the best single predictor not only for mathematical understanding but also for success in reading recognition.

It will be recalled from the previous paper that while operativity and language constitute distinct factors at the second-order level as well as the first, they are highly correlated. The extent of the correlation is apparent in Table 2 (·66). Despite the considerable differences between the several measures of language used in the enquiry, they all had this in common: presentation and/or response were verbal, and content was thematic (interactions of people or animals, familiar objects, etc.) By contrast the response required in the operativity measures was often practical (e.g., re-arrangement of rods, selection of shapes), and the material used tended to be more formal (geometric shapes, rods, etc.) Thus the basis for the differentiation between these two factors must remain an open question. On the one hand, following Piaget, it could be taken as pointing to a fundamental distinction between the operative and figural aspects of cognitive processing. On the other hand, the differentiation could be thought of as content based (thematic *versus* formal) and therefore wholly within the figural aspect. The strength of the Piagetian measures in predicting reading, while not conclusive, may nevertheless be thought of as providing some support for the first hypothesis.

That operativity is more relevant than language may seem fairly plausible for mathematical understanding, especially if the Piagetian hypothesis is correct. At first sight, however, the same observation in regard to reading may seem somewhat paradoxical. Before considering reasons some consideration must be given to a possible objection.

Thus it may be argued that language was superior to operativity in predicting reading comprehension and that the principal measure of reading was a test of word recognition. After all, reading is not just a matter of making out words. But the decision to use Schonell's test as the main criterion was arrived at only after establishing that, despite its questionable face validity, this measure gave almost identical results to two others that were given with the specific aim of overcoming the problem. It seems clear that, at this level, the familiar word recognition test is as valid a measure of reading skill as any. This is very probably because in any text or test designed for very young children, both sense and grammar must be kept simple. (If they were not, the test would be a measure of intelligence). So it is that in the Neale and Daniels and Diack tests, both good measures of reading, if a child can make out the words, he can also make out the sense. The correlation between sentence reading and word recognition is not accidental but intrinsic. The teaching of reading must begin with the language that the child already knows and knows well. If it does not, it is simply bad teaching. Tests of reading merely follow suit.

The suggestion that differences in operativity affect the learning of reading while differences in language skills have no independent effect may seem paradoxical. After all, reading is a linguistic skill. As a matter of fact, this finding was not anticipated at the start. But it should have been. In fact, the formulation given at the head of this paragraph is a little different from that discussed so far. The modification lies in the inclusion of the words ' differences in ' and herein lies the essential clue. Certainly language is essential to the learning of reading. But it does not follow that differences in language skills at age 6 play any significant part in determining differences in learning to read. Because the language used in texts is simple, differences in linguistic ability do not greatly affect the child's ability to profit from instruction. By and large, even the poorest speakers are familiar with the words and the structures met with in initial readers. On the other hand, the processes that figure in tests of operativity: classification, seriation, reflexion, analysis, are very much those that are required in learning to read. Some years ago, in collaboration with G. R. Roberts, (Roberts and Lunzer, 1968, pp. 43-44), the senior writer listed as follows the several abilities that go to make up initial reading:

(1) That the printed text provides visual cues to a language message (if you look at the page you can get a story).

(2) That the shapes of letters, words and spaces offer differential cues.

(3) That there is a one-one correspondence between the temporal sequence of words as spoken and the left to right spatial sequence of words as printed—with spaces between words corresponding to (possible) minimal pauses in speech.

(4) (5) Differentiation of letter shapes and identification of letter shapes corresponding to their phonic contributions.

(6) That there is an approximate one-one correspondence between the left to right spatial sequence of letters and the temporal sequence of phonemes.

(7) (8) Differentiation and identification of digraphs.

(9) The strategy of forming a temporal synthesis of meaningless vocal syllables obtained by following a left to right sequence to form a meaningful word.

(10) (11) Differentiation and identification of frequent letter strings (-tion, -ing, in-, etc.)

(12) A variety of strategies for scanning words corresponding to ' phonic ' rules determining correspondences between spoken and printed words other than those which depend solely on the correspondence of spatial and temporal order, and including rules for syllabification.

(13) Progressive automatisation of strategies (1) to (12).

Every one of these skills makes demands on the processes that are subsumed under the heading of ' operativity.'

The findings relating to STM are striking. The auditory and the visual tests differed only in mode of presentation and response; both required sequential reproduction. Yet while the auditory STM measures made no independent contribution to the prediction of performance on any of the criteria, the contribution of the visual measures prove highly significant in predicting reading. These data lend strong support to the view that significant progress in learning to read depends on the ability to discriminate between different sequential orderings of visual symbols and to retain a memory image of such sequences. It would appear that such an ability is in large measure specific, distinct both from language and operativity, and furthermore, that variation in the ability at about the age of 5½ is critical to progress made during the following year. Conversely, deviation in the ability to retain a sequence of auditory symbols *per se* is not critical for reading.

Prediction of reading comprehension is strongly associated with story recall and it is arguable that the test is as much a measure of meaningful memory as it is an index of reading efficiency. This is because the tester is instructed to correct any word that is misread (or supply it if it is omitted) while the story is read by the child. It follows that subsequent questioning will tap recall of the material rather than the efficiency of its reading. Nevertheless it is interesting to note once again the important contribution of STM for visual sequencing.

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APPENDIX

A test of mathematical understanding for children aged 6-7 years.

In the absence of any satisfactory measure of mathematical understanding for this age group, it was decided to construct one that might serve the needs of this enquiry in the first instance. It is not claimed that the resultant instrument is a properly standardised test. However, the data given above may be taken as a promising indication of construct validity.

The test is made up of 33 items; it is administered individually and takes 20-30 minutes. Its coefficient of reliability (Kuder-Richardson formula 20) is ·87 (N=180, data from the present study).

The overall mean was found to be 16·11 (SD=6·15). Discrimination is generally satisfactory as is shown by the following percentage distribution scores:

1-3	1 per cent
4-8	10 per cent
9-13	24 per cent
14-18	29 per cent
19-23	24 per cent
24-28	10 per cent
29-33	2 per cent

The following items give an indication of the types of questions used.

Questions	
3-6	Comparing number of flowers arranged round the circumference of two plates.
11-12	Equalisation of differences.
21-22	Enlargement of triangles (using geoboard and elastic bands).
30	What number is one more than 28?
33	What number is two less than 21?

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AN INVESTIGATION OF LEVEL I AND LEVEL II COGNITIVE PROCESSES IN THE LEARNING AND RECALL OF FACTUAL AND INFERENTIAL INFORMATION

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Summary. This study relates Jensen's dual-process theory of cognitive functioning to the performance of 10-11 year-old children on the learning of both factual and inferential information. Using Digit Span and Raven IQ scores, a total of 84 children was divided into four groups, scoring high and/or low on Level I (associative) and Level II (conceptual) abilities respectively. The performance of these groups was then compared on short-term recall of factual and inferential listening comprehension items and on longer-term recall of factual and inferential items in a test based on a prepared social studies lesson. It was hypothesised that conceptual ability would have the stronger relationship to performance on inferential items, but that associative ability would facilitate performance on factual items. Some evidence was found for the facilitative effect of high associative ability on recall of factual information in the social studies test but not in listening comprehension. Conceptual ability was by far the stronger determinant in the recall of both factual and inferential information. These results suggest that Jensen's dual-process theory has not yet demonstrated its utility in the area of school learning.

INTRODUCTION

In his 1969 article, " How much can we boost IQ and scholastic achievement? " Jensen proposed a dual process hypothesis of cognitive functioning which, if proved valid, would have considerable influence on classroom teaching practices. However, the educational implications of the theory have been largely overlooked in the debate concerning the assumptions and bases relating to social class, race and genetic intelligence on which the theory is constructed. The validity of Jensen's hypothesised Level I and Level II abilities, described as ingenious but insufficiently substantiated to warrant practical innovations in teaching techniques (Butcher, 1972), has not been clarified in spite of numerous published theoretical papers. The research presented here represents an attempt to clarify the validity of the theory through empirical investigation. In particular, this study attempts to relate Jensen's Level I associative ability and Level II conceptual ability to the learning of meaningful verbal materials appropriate for the solution of factual and inferential problems presented in classroom-like situations.

The cognitive processes involved in the solution of factual and inferential problems in verbal material appear similar to Jensen's descriptions of the processes involved in Level I and Level II abilities (see for example Jensen, 1970, 1972). Level I is described as an associative ability in which there is a simple, direct correspondence between the stimulus information and the response output. Since there is little transformation of the stimulus input in making the response the subject must accurately register the material to be learned and be able to repeat this material in similar form in response to some partial stimulus cue. These processes seem particularly appropriate for the recall of specific or factual pieces of information presented during a class lesson. In a lesson a child might hear the statement, " Quito is the capital city of Ecuador " and later he might be asked " What is the capital city of Ecuador? " In responding, " Quito is the capital of Ecuador " the child has not elaborated or transformed the original stimulus information. In Jensen's terms, the learning is like a recording which is played back in response to a partial stimulus cue.

In contrast, Level II is described as a conceptual ability in which the response is made only after the original stimulus for learning has been transformed or elaborated, which often involves some comparison of the informational input with previously stored information. Although this involves accurate registration of the material to be learned, the response may bear little resemblance to the original stimulus input. These processes seem intimately linked with the processes involved in making inferences from meaningful verbal material. Inferential problems cannot be solved simply by recalling a specific piece of information. Rather they depend on a different process involving reflection on a number of pieces of information and synthesis of the components to abstract an answer. That is, the subject is required to go beyond the stimulus information presented; he must engage in complex mental manipulations of the input in order to extract implications that are not immediately apparent.

If the processes believed characteristic of Level I and Level II abilities parallel the processes assumed to underlie performance on factual recall tests and inferential tests respectively, then scores on these latter tests should be related in predictable ways to scores on tests of associative and conceptual abilities. Similarities and differences in factual achievement test performance should be related to similarities and differences in associative ability. Similarities and differences in inferential achievement test performance should be related to similarities and differences in conceptual ability. In particular it can be hypothesised that those scoring highly on tests of associative ability, irrespective of their level of conceptual ability, should perform well on achievement tests demanding accurate recall of factual information.

METHOD

Sample.

284 children, aged approximately 10 to 11 years, participated in this study. Standard four children were chosen since Jensen (1970) suggests that associative and conceptual abilities should be almost fully developed by this age. The children constituted nine classes selected to reflect the range of normal school academic abilities. The analyses presented in this study are based on the 84 children who had low and/or high scores on the Raven IQ and Digit Span tests. The number of boys and girls was approximately the same for all groups.

Tests of Level I and Level II Abilities.

Associative Ability: Jensen (1969) suggests that the best available measures of Level I associative ability include memory span for digits (both forward and backward), serial rote learning, free recall of uncategorised word lists, and paired associate learning tasks. Following a pilot investigation of a number of these tasks, this study used a memory test of digits forward. The test consisted of 27 items ranging in length from three to eight digits. The items were presented in mixed order to prevent children from using pre-arranged strategies to aid recall of an anticipated series length (as may occur in the graded series of items used, for example, in the Wechsler scales of intelligence). The test and instructions were pre-recorded on audio tape to maintain a standard presentation in all classrooms. Classes listened to each item and wrote down the digits in the order in which they were heard. Each child's test score consisted of the number of items correctly recalled.

Conceptual Ability: Jensen (1969) further suggests that the best available measures of Level II conceptual ability are the Raven Progressive Matrices and Cattell's Culture Fair tests. In this study conceptual ability was measured by the Standard Progressive Matrices (Raven, 1958), a group intelligence test employing abstract non-verbal problems designed to test a person's capacity to determine the relationships among a set of geometric figures. An IQ score was determined for each child.

Dependent Measure Materials.

PAT Listening Comprehension: The Progressive Achievement Test of Listening Comprehension (Elley and Reid, 1971) is a standardised test measuring the processes of comprehending and drawing inferences about extended passages of orally presented verbal material. The tests are designed to measure both simple recall skills (receptive listening) and inferential comprehension (reflective listening). The two types of test items are described as follows:

> " The recall items test the ability of the pupil to remember the facts and ideas explicitly set forth in the passage. Included in this category are the ability to recall details and stated ideas, to follow oral directions and to note order and sequences of events, as stated in the selection listened to. Inferential items require the pupil to make inferences of the following kinds: to determine the speaker's intention, mood or point of view, to establish the theme or main point of the passage, to relate general themes to supporting details, to distinguish relevant from irrelevant material, to note relationships among the details and the significance of these, to draw conclusions about people and events described and to predict future events which could be inferred from the selection heard."
>
> (Elley and Reid, 1971, pp 5-6).

Part Four of Form B consists of seven passages varying in length from approximately 150 to 400 words, each passage being followed by a number of recall and inferential items of the multiple choice type, giving a total of 24 factual and 18 inferential items. The equivalent forms reliability of the test at this level is quoted as ·78. The test takes approximately 50 minutes to administer.

Social Studies Lesson: Since the PAT test involves passages of only a a couple of minutes duration followed by immediate testing, a social studies lesson of 35 minutes duration, with testing delayed for 24 hours, was prepared. The lesson concerned the history and geography of Ecuador, a country not taught as part of the regular social studies syllabus for these children. A recording of the lesson was made on videotape and was reproduced in each classroom via two 19-inch television monitors.

Social Studies Pre-test and Attitude Scale: Since post-test scores may be partly a function of prior knowledge and/or attitude towards the subject, separate pre-test and attitude tests were developed and administered. The pre-test contained 15 general knowledge multiple choice questions about Ecuador. These questions did not appear in the post-test. Attitude towards social studies was estimated using 12 semantic differential scales with a total test internal consistency reliability coefficient of ·88 computed by the Kuder-Richardson formula 20 method.

Social Studies Post-test: The post-test contained equal numbers of factual and inferential questions, as defined in the PAT Listening Comprehension test and agreed upon by at least three out of four primary school teachers. The 30 factual and 30 inferential items represent those pilot pool items having discrimination indices above ·60 (following Anstey's 'D' method, 1966) and easiness indices ranging from 35 per cent to 78 per cent. Median discrimination indices for the factual and inferential tests were ·96 and ·81 respectively, while median easiness indices were 54 and 53 per cent respectively. Internal reliability coefficients for the two tests were ·78 and ·72 respectively, calculated by the Kuder-Richardson formula 20 method.

PROCEDURE

Each of the nine classes received the same test at approximately the same time each testing session. The same experimenter conducted all test sessions in all classrooms. The Raven IQ and Digit Span tests were administered on successive days in July, while the PAT Listening Comprehension test was administered approximately one month later. The social studies materials were presented in October. In presenting the social studies materials subjects received, in order, the attitude scales, the Ecuador pre-test, and the videotaped lesson on the first day. The post-test was given the following day.

The analyses of PAT Listening Comprehension and social studies test results are based on the scores of the children who had high and/or low scores on the Raven IQ and Digit Span tests. Mean scores and standard deviations of the Raven IQ and Digit Span tests are presented in Table 1. Scores on both tests approximated a normal distribution.

TABLE 1

SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS

Test		
Digit Span	Mean SD N	10·51 4·76 284
Raven IQ	Mean SD N	109·42 12·92 290

For the purpose of this study a high or a low score was designated as falling in the upper one third or lower one third of the total distribution of scores for each test. Thus, a high score on the Digit Span test was a score of 13 or better while a low score included all scores below nine. A high score on the Raven IQ test was 116 or better while a low score was 103 or below. In both tests the difference between the upper and lower cut-off levels was greater than one standard deviation.

From the original sample of 284 subjects having scores on both tests the following ability groups could be established (with group sizes in parentheses):

Group 1 (52) low associative/low conceptual abilities

Digit Span	8 points or less
Raven IQ	103 points or less

Group 2 (17) high associative/low conceptual abilities

Digit Span 13 points or more
Raven IQ 103 points or less

Group 3 (18) low associative/high conceptual abilities

Digit Span 8 points or less
Raven IQ 116 points or more

Group 4 (43) high associative/high conceptual abilities

Digit Span 13 points or more
Raven IQ 116 points or more

Because of the need to match groups classified as similar with regard to type of intellectual ability (e.g., Groups 1 and 3 should have similar mean scores on the Digit Span test) *t* tests were computed for the appropriate group differences. No significant differences were found between groups presumed matched for Raven IQ. Marginally significant mean differences were found between groups presumed to be matched on the basis of Digit Span score. These differences were reduced when several of the extremely low and extremely high Digit Span scores were discarded. As a result of the removal of these extreme scores, and the attrition rate over the three months of testing, the number of subjects remaining in the groups became 19 (Group 1), 17 (Group 2), 17 (Group 3) and 31 (Group 4).

The mean scores and standard deviations of each of the four groups on the Digit Span and Raven IQ tests are contained in Table 2. Perusal of this table indicates that groups presumed to be matched in terms of high or low associative or conceptual ability have similar mean scores. The greatest mean difference is the 3·13 IQ points between the mean scores of Groups 1 and 2 (presumed to be of similarly low conceptual ability) but this difference is not statistically significant (F=2·07, df=1/34, P>·10).

TABLE 2

SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS FOR THE FOUR ABILITY GROUPS.

Test		Group 1	Group 2	Group 3	Group 4
Digit Span	Mean	6·79	15·53	6·88	15·52
	SD	1·06	1·88	1·41	1·95
	N	19	17	17	31
Raven IQ	Mean	93·58	96·71	123·77	123·16
	SD	6·08	6·60	5·82	5·23
	N	19	17	17	31

It is necessary at this point to make particular mention of Group 3 (low Level I/high Level II abilities), the identification of which appears to pose considerable difficulties for Jensen's dual-process hierarchical theory of mental abilities. Jensen (1973, p. 221) clearly supports the notion of a Level I/Level II hierarchy "... in which the development of lower levels in the hierarchy is necessary but not sufficient for the development of the more complex levels ..." If such an hierarchy is valid, it follows that it should *not* be possible to identify a group of children with low Level I and high Level II abilities, i.e., Group 3. Jensen

(1973, p. 76) documents the fruitless search for evidence bearing on the hypothesised ' twisted pear ' correlation between Level I and Level II abilities implied by his hierarchical theory. We also examined the bivariate distribution of Level I and Level II abilities for the total sample (N=284) but found no evidence for the ' twisted pear ' conformation. The correlation between Digit Span and Raven scores was +0·40 and the relationship was strictly linear. Inevitably, therefore, it was possible to identify a group of children classified as low Level I/high Level II.

The continued failure of research to find evidence for the 'twisted pear' relationship between Level I and Level II abilities undoubtedly raises questions regarding the validity of Jensen's hierarchical theory, though the possibility cannot be excluded that these Group 3 children form a special group of intelligent but highly anxious and distractable children whose performance on tasks of short-term memory is seriously impaired. Fortunately, the presence of this ' impossible ' Group 3 does not seriously affect the present study. As mentioned earlier in this report the really critical group in this study is Group 2, i.e., those children with high Level I/low Level II abilities. In the presentation of the experimental results which now follows this emphasis will become clear.

RESULTS

Correlations between the social studies attitude scale and the social studies factual and inferential post-tests were ·14 and ·12 respectively. Since neither of these correlations was significant the attitude scale scores were abandoned as a control variable for final performance on the social studies post-tests. Significant correlations of ·32 and ·25 were found between the Ecuador pre-test and the factual and inferential post-tests respectively. Predicted achievement on each post-test was determined by plotting total mean post-test performances for each level of the pre-test. Residual achievement scores for each individual were calculated by subtracting predicted achievement scores from actual achievement scores on the post-test.

The analyses presented here are based on the residual achievement scores for the social studies post-tests and the raw score data for the PAT Listening Comprehension tests.

Factual Tests.

A 2×2 (Digit Span×Raven IQ) weighted means analysis of variance was carried out on the 24-item factual PAT Listening Comprehension test for the four groups. While the Raven IQ main effect was significant ($F=27{\cdot}05$, $df=1/80$, $P<{\cdot}01$), there were no significant effects for Digit Span or the interaction of Digit Span and Raven IQ. Pairwise multiple comparisons using the Newman-Kuels method (Winer, 1971) revealed differences, significant at the 1 per cent level, between Groups 1 and 3, 1 and 4, 2 and 3, and 2 and 4. No significant differences were found between Groups 1 and 2 and Groups 3 and 4. The mean scores for the four groups are shown in Figure 1.

A further 2×2 weighted means analysis of variance was carried out for the residual achievement scores on the 30-item factual social studies post-test for the four groups. Significant effects were found for Raven IQ ($F=39{\cdot}93$, $df=1/80$. $P<{\cdot}01$) and the Raven IQ-Digit Span interaction ($F=8{\cdot}13$, $df=1/80$, $P<{\cdot}01$) The Digit Span main effect was not significant. Following a test of multiple comparisons, significant differences were found between the residual achievement mean scores of Groups 1 and 3 ($P<{\cdot}01$), 1 and 4 ($P<{\cdot}01$), 2 and 3 ($P<{\cdot}01$), 2 and 4 ($P<{\cdot}05$), and 1 and 2 ($P<{\cdot}05$). No significant mean difference was found between the scores of Groups 3 and 4. The adjusted mean achievement scores, controlled for prior knowledge of Ecuador, are shown in Figure 2.

FIGURE 1

MEAN SCORES ON THE FACTUAL ITEMS OF THE PAT LISTENING COMPREHENSION TEST AS A FUNCTION OF SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS.

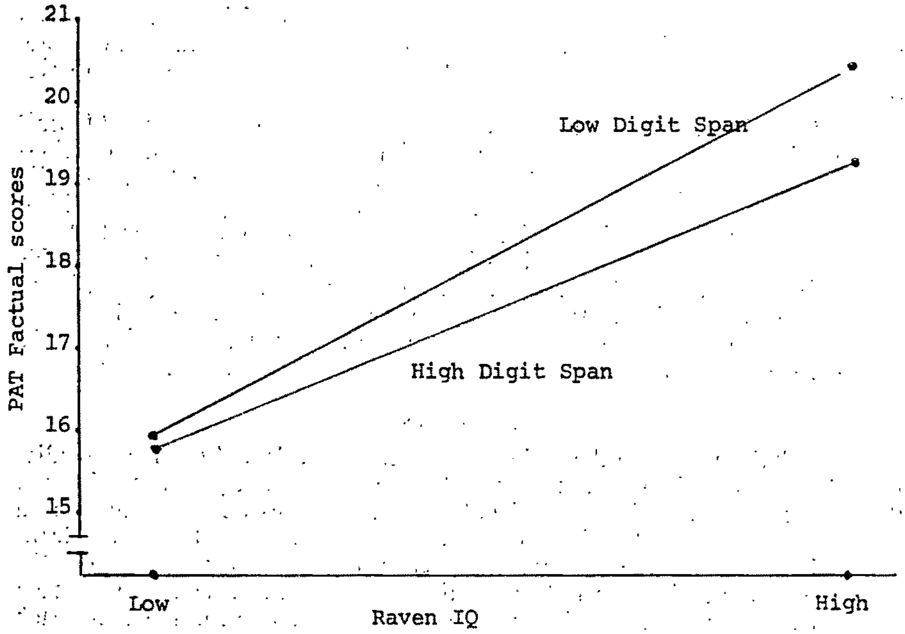
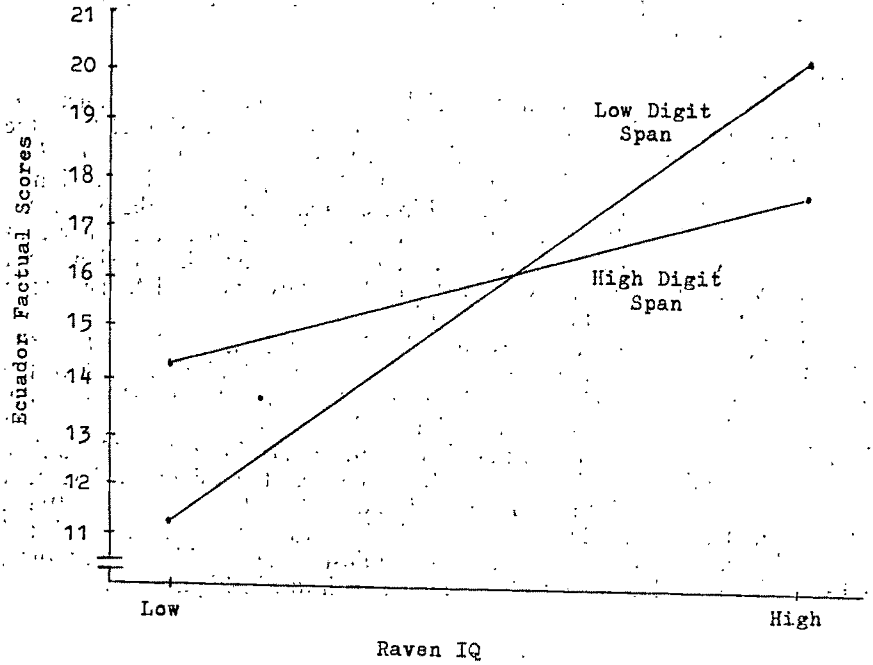


FIGURE 2

ADJUSTED MEAN ACHIEVEMENT SCORES ON THE ECUADOR FACTUAL ITEM POST-TEST AS A FUNCTION OF SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS.

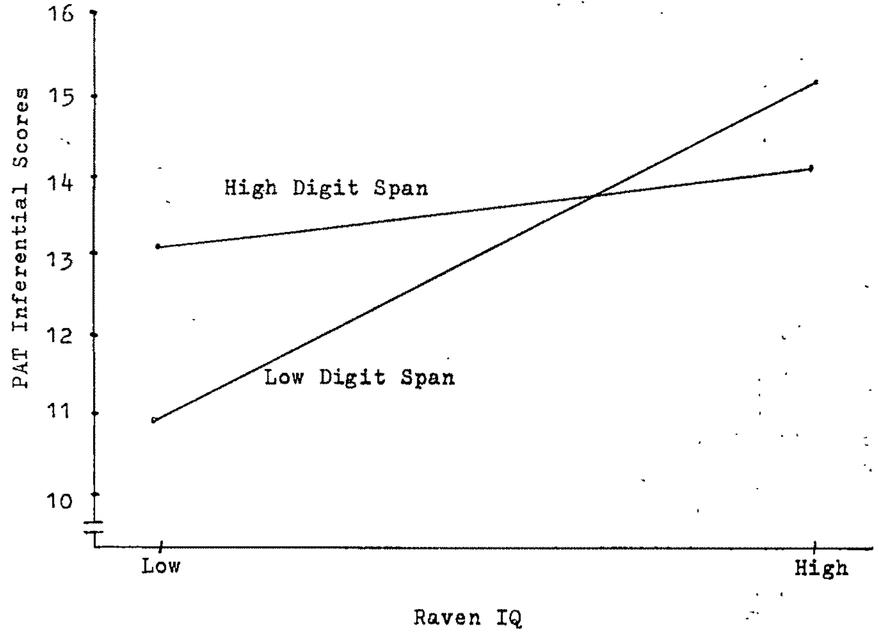


Inferential Tests.

A third 2×2 weighted means analysis of variance was carried out on the 18-item inferential Listening Comprehension test for the four groups. Significant effects were found for Raven IQ (F=32·57, df=1/80, P<·01) and the interaction of Raven IQ and Digit Span (F=12·74, df=1/80, P<·01), but not for the Digit Span effect. The mean differences between Groups 1 and 2, 1 and 3, 1 and 4, and 2 and 3 were significant at the 1 per cent level, but the mean differences between Groups 2 and 4 and 3 and 4 were not statistically significant at the 5 per cent level. The mean scores are shown in Figure 3.

FIGURE 3

MEAN SCORES ON THE INFERENTIAL ITEMS OF THE PAT LISTENING COMPREHENSION TEST AS A FUNCTION OF SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS.



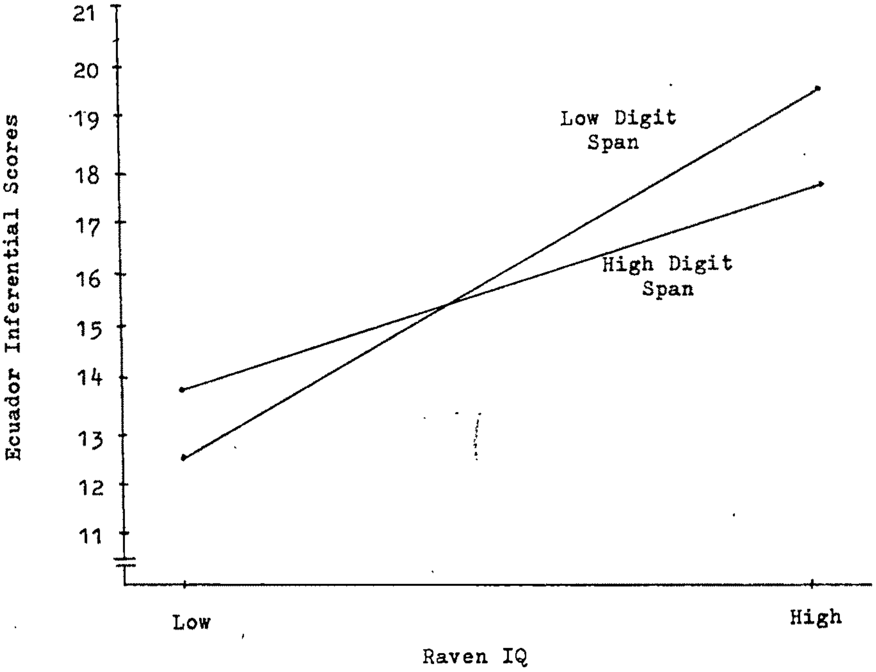
The final 2×2 weighted means analysis of variance was carried out on the residual achievement scores on the 30-item inferential social studies post-test for the four groups. Only the Raven IQ main effect was significant (F=42·88, df=1/80, P<·01). An F test of mean differences revealed no significant differences between the mean scores of Groups 1 and 2 and 3 and 4. However, differences significant at the 1 per cent level were found between the mean scores of Groups 1 and 3, 1 and 4, 2 and 3, and 2 and 4. The adjusted mean achievement scores controlled for prior knowledge of Ecuador are shown in Figure 4.

DISCUSSION

The results of this study give little support to the notion that Level I associative ability underlies performance on factual achievement tests, in spite of Jensen's descriptions of this ability being closely related to the processes thought to be involved in the solution of factual recall problems. On both factual achievement tests Raven IQ was the major determinant of performance while Digit Span did not achieve significance. However, scores on the social studies factual post-test indicate some evidence for a facilitative effect of high Digit Span score for children of low conceptual ability, as shown in the significant mean difference between the scores of Groups 1 and 2. It must be noted, however, that the significant interaction effect between Raven IQ and Digit Span is most probably a result of the correlation between these two tests of approximately ·40 in this study.

FIGURE 4

ADJUSTED MEAN ACHIEVEMENT SCORES ON THE ECUADOR INFERENTIAL ITEM POST-TEST AS A FUNCTION OF SCORES ON THE DIGIT SPAN AND RAVEN IQ TESTS.



Ideally, if the recall of factual information involved only associative ability as measured by the Digit Span task, the results should conform to the graph shown in Figure 5 where higher achievement is associated with higher Digit Span score. Even if it could be supposed that children low in associative ability but high in conceptual ability (Group 3) could use Level II conceptual processes to aid in the learning and recall of the materials the results should still conform to the graph shown in Figure 6. However, most scores in this study have been determined by Raven IQ and the similarities and differences in achievement do not parallel those in associative ability.

FIGURE 5

A GRAPH OF A HYPOTHETICAL RELATIONSHIP BETWEEN DIGIT SPAN, RAVEN IQ AND ACHIEVEMENT SCORES ON TESTS OF FACTUAL ITEMS.

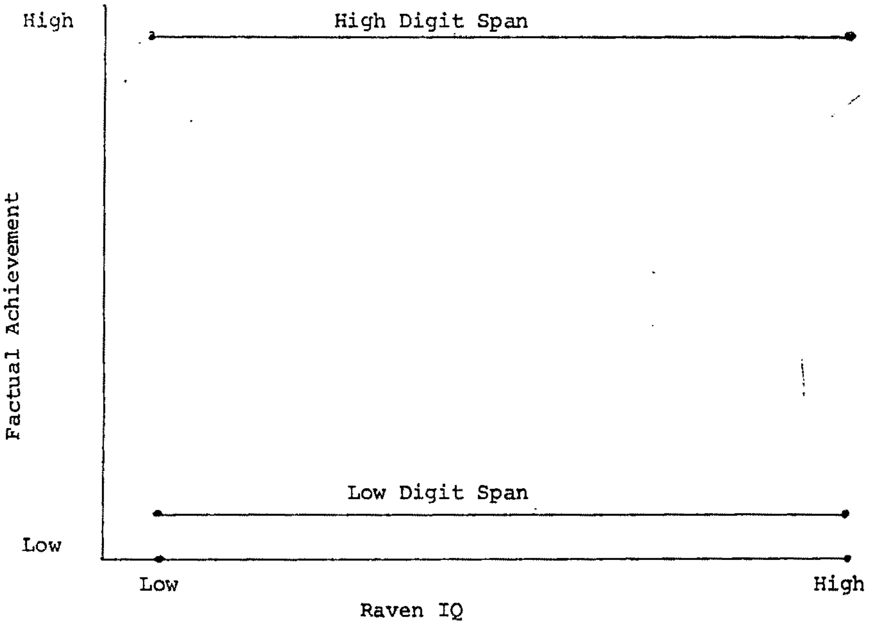
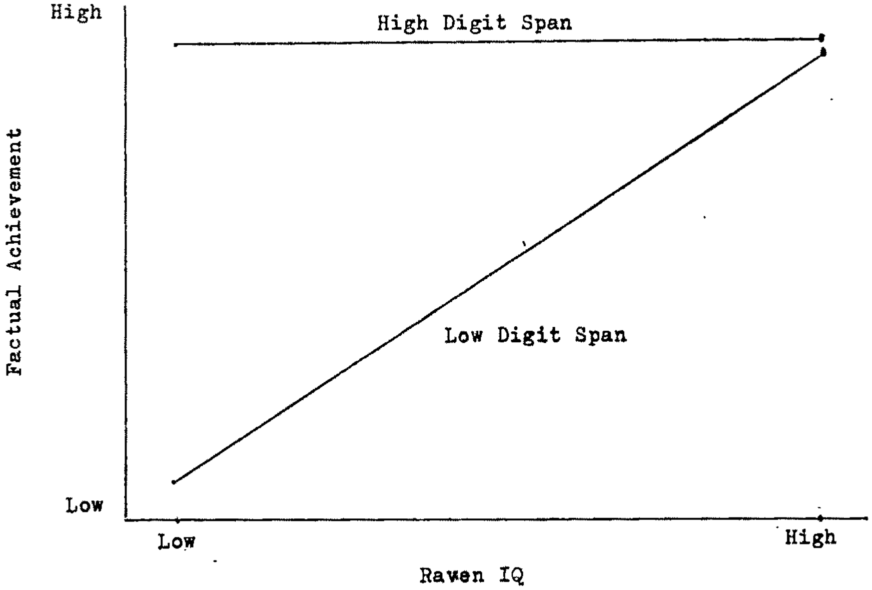


FIGURE 6

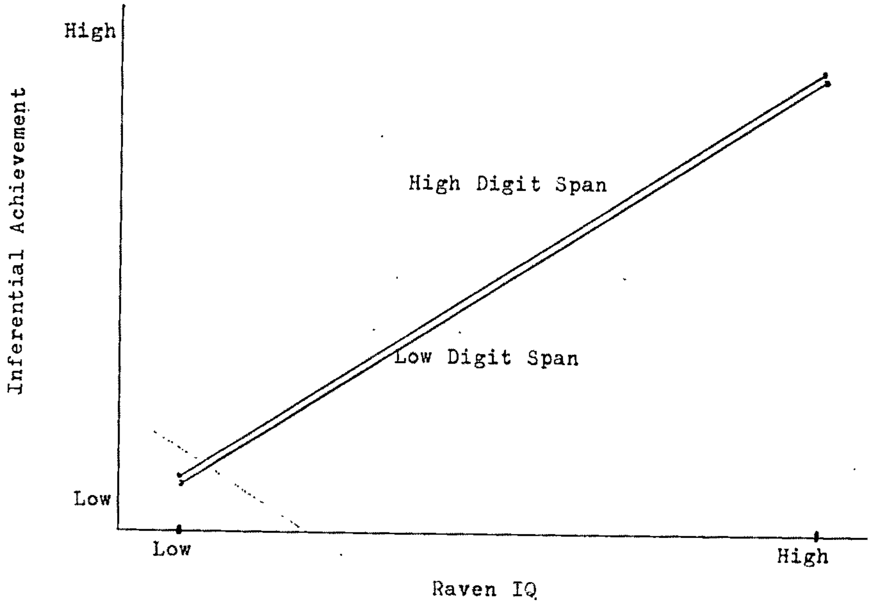
A FURTHER GRAPH OF A HYPOTHETICAL RELATIONSHIP BETWEEN DIGIT SPAN, RAVEN IQ, AND ACHIEVEMENT SCORES ON TESTS OF FACTUAL ITEMS.



As predicted, the results indicate that Raven IQ is the major determinant of scores on the inferential achievement tests. The mean scores on the Ecuador inferential post-test show differences and similarities that precisely parallel similarities and differences in conceptual ability. However, the results of the PAT Listening Comprehension inferential test are somewhat equivocal since groups presumed to be of similarly low conceptual ability (Groups 1 and 2) had significantly different mean scores, while the mean score of Group 2 was not significantly different from that of Group 4 (of high conceptual ability). Ideally, if the inferential achievement involved only conceptual ability as measured by Raven IQ score, the results should conform to the graph shown in Figure 7, where inferential achievement is linearly related to IQ. However, because of the interaction between Raven IQ and Digit Span (significant at $P<\cdot 001$ and $P<\cdot 078$ for the PAT and social studies inferential tests respectively), the effects of Digit Span in the recall of inferential material cannot be discounted altogether, even if the interaction is a result of the correlation between the two tests.

FIGURE 7

A GRAPH OF A HYPOTHETICAL RELATIONSHIP BETWEEN DIGIT SPAN RAVEN IQ, AND ACHIEVEMENT SCORES ON TESTS OF INFERENTIAL ITEMS.



In conclusion, these results give little encouragement to the educational implications of Jensen's dual process hypothesis of cognitive functioning. The usefulness of the theory rests on the classroom validity of Level I associative ability, which Jensen (1969) claims is as effective as conceptual ability in the learning of certain school skills. At the very least this investigation has shown the marginal educational relevance of associative ability, even for Group 2 which is the critical group of concern for Jensen since these children are presumed to account for the majority of unnecessary school failures. Furthermore, Jensen's belief in only simple mental processes being involved in associative ability as measured by the Digit Span test must be questioned in the light of the higher achievement of Group 2 over Group 1 on problems involving complex reasoning, the interaction effects of Digit Span and Raven IQ, and the significant correlation between the two latter tests.

Finally, it must be noted that while the associative and conceptual abilities are not precisely defined, while the validity of these ' best available ' measures of the abilities is not known, and while there is no account of the way these abilities relate to what goes on in the classroom, specific tests of the theory are difficult to make. In the absence of any definitive research extending the positive claims of Jensen's hypothesis we must conclude that although there may be large numbers of children failing unnecessarily in our schools, the theory does not yet offer a method of identifying them or of suggesting effective modifications of the teaching process in order to prevent such failure.

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THE EFFECTS OF PICTURES ON LEARNING TO READ

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SUMMARY. 20 children learned to read single words that were presented together with (i) a picture of the object named by the word, (ii) a picture of an object unrelated to the word, (iii) a 'nonsense' picture not resembling any object, and (iv) no picture of any kind. Presence of an appropriate picture resulted in significantly fewer correct responses than any other condition. The no-picture condition was the most favourable for learning to read, and it also resulted in largest number of correct responses after a retention interval of 28 days. Learning by massed or distributed practice over time did not affect these relationships although in all conditions distributed practice resulted in more correct responses. The results indicated that whether pictures adversely affect learning to read or not depends on the relationship between the picture and the printed word, a direct equivalence being the least favourable.

INTRODUCTION

It is an almost invariable practice to include pictures in reading-books designed for younger children. The existing evidence indicates, however, that pictures do not enhance the comprehension of a text (Vernon, 1953, 1954; Weintraub, 1960), and that learning to read is actually retarded in the presence of pictures (Harris, 1967; Samuels, 1967; Braun, 1969). Although the latter finding has important implications for the teaching of reading, it has not yet been fully investigated.

For example, it is not clear from the existing evidence if pictures are generally detrimental to the learning of reading or if the effect is confined to those cases where there is a specific relationship between the picture and the printed text. Samuels (1967) has reported the results of two experiments that have a bearing on this problem. In one experiment words were presented singly, either with or without a picture. Children in the condition without pictures required fewer trials to learn the printed words. In the second experiment children were taught to read a 50-word story either with or without a picture which was related to the story in a general way. The presence of the picture was found not to affect performance. (Less able children who are known to be readily distracted by extraneous stimuli performed poorly in the presence of the picture; cf. Santostefano *et al.*, 1965).

These two sets of results suggest that the nature of the relationship between the picture and the printed text may be an important variable for determining the extent to which pictures interfere with learning to read. This suggestion was investigated in the present experiment.

METHOD

Sample.

10 boys and 10 girls, all of whom were pupils at a primary school, took part in the experiment. Their chronological ages were between 5·9 and 7·0 (Mean= 6·5), and their reading ages between 5·0 and 7·0 (Mean=6·0). The reading ages were measured using the Schonell Word Recognition Test. The children were pre-tested to ensure that they could not read the words used in the experiment.

Design

5 boys and 5 girls were randomly assigned to each of the following two groups: (i) massed-practice, and (ii) distributed-practice. There were four experimental conditions: (i) ' appropriate-picture,' (ii) ' inappropriate-picture,' (iii) ' nonsense-picture,' and (iv) ' no-picture.' The printed words in these conditions were accompanied by, respectively, a picture showing the object named by the word, a picture of an object unrelated to the word, a picture not resembling any object, and a blank surface without a picture. These four conditions were presented, in mixed order, to both groups of subjects.

Materials.

16 words were selected from two books in a popular series of reading books for children. Brightly coloured pictures in these books were also used. Stimulus-cards measuring 13 cm × 18 cm were made by pasting one of these pictures on a card and printing one of the words below it in 2 cm high lower case letters.

Four words were randomly allocated to each of four experimental conditions, as follows: (i) ' appropriate-picture ' condition: mittens, chocolate, stairs, orange; (ii) ' inappropriate-picture ' condition: shoe, newspaper, watch, pencils; (iii) ' nonsense-picture ' condition: tricycle, banana, telephone, socks; (iv) ' no-picture ' condition: keys, bath, biscuits, teddy. The inappropriate pictures were selected randomly from amongst all the available pictures except those appropriate to any of the words used in the experiment. For the ' nonsense-picture ' condition several pictures were cut into small pieces of approximately 2 cm × 1 cm, and the pieces were put together in mixed order to form a picture that did not resemble any object. For the ' no-picture ' condition the words were printed in the same position as in the other conditions, but without any accompanying picture. 16 test cards were also prepared in this way.

Procedure.

The experiment was conducted individually with each subject. At the beginning of the first session the child was instructed as follows: " I am going to show you cards with a word written on each card. Try to read the word. If you cannot, I will read it to you. When we have gone through all the words I will show them to you a second time, to see if you have learned to read any that you could not read before." No reference was made to the pictures, and the children did not comment on their presence.

In an acquisition session all of the 16 stimulus-cards were presented, one at a time and in mixed order. If the subject correctly said the word on the card he was immediately so informed. If he made an error or if he made no response, the correct word was said by the experimenter. A maximum of 20 seconds was allowed for each response.

A test session consisted of the presentation of the 16 test-cards, one at a time and in mixed-order. In these sessions the subject was not informed of whether his response was correct or not. The acquisition and test sessions alternated, a total of 20 sessions (10 acquisition and 10 test) being conducted with each subject.

The subjects in the massed-practice group received all 20 sessions in one day, with a rest period of one minute between each session. The subjects in the distributed-practice group received one acquisition and one test session per day, in two sequences of five consecutive days separated by a weekend.

Finally, a single test session was conducted with each subject, 28 days after the completion of the main experiment with that subject.

RESULTS

Table 1 shows the mean scores and standard deviations of the number of correct responses made under each experimental condition in the acquisition and test sessions. The data were converted into difference-scores by subtracting the number of correct responses in test sessions from the number of correct responses in acquisition sessions. This takes into account any effect that might be due to the fact that the words used were different in the four experimental conditions. Analysis of variance was carried out on the difference-scores, showing that performance in the massed and distributed practice groups did not significantly differ ($F=4{\cdot}17$, $df=1,72$). There was, however, a significant difference between the experimental conditions ($F=16{\cdot}06$, $df=3,72$, $P<0{\cdot}01$). The four conditions were therefore compared using Duncan's New Multiple Range Test (Edwards, 1960, p. 136). The 'appropriate-picture' condition differed significantly from all other conditions ($P<0{\cdot}01$). There was no significant difference between the other conditions, with the only exception of the difference between the 'nonsense-picture' and the 'no-picture' conditions ($P<0{\cdot}05$).

TABLE 1

MEAN AND STANDARD DEVIATION OF THE NUMBER OF CORRECT RESPONSES IN EACH CONDITION.

Acquisition				
Condition	Massed		Distributed	
	M	SD	M	SD
Appropriate-picture	37·40	3·58	39·10	0·83
Inappropriate-picture	28·90	6·30	27·10	5·07
Nonsense-picture	24·30	8·84	25·30	4·50
No-picture	27·10	8·42	25·40	5·60
Test				
Condition	Massed		Distributed	
	M	SD	M	SD
Appropriate-picture	24·40	10·72	27·70	4·10
Inappropriate-picture	25·90	11·72	29·10	5·72
Nonsense-picture	19·30	13·29	25·30	4·73
No-picture	29·40	9·69	29·50	4·97

The number of correct responses made in only the test sessions were also analysed using the same method as above. The experimental conditions differed significantly, ($F=15{\cdot}34$ $df=3,72$, $P<0{\cdot}01$) and Duncan's New Multiple Range Test showed that the 'no-picture' condition significantly differed from the 'appropriate-picture' and the 'nonsense-picture' conditions ($P<0{\cdot}01$ in each case). There was also a significant difference between massed and distributed practice ($F=16{\cdot}65$, $df=1,72$, $P<0{\cdot}01$), distributed practice resulting in more correct responses in test sessions.

TABLE 2

CORRECT RESPONSES IN THE RETENTION TEST IN NUMBER AND AS PERCENTAGE OF CORRECT RESPONSES IN THE PRECEDING TEST SESSION.

Condition	Massed		Distributed	
	Number	Percentage	Number	Percentage
No-picture	37	100	39	97·5
Appropriate-picture	22	71·0	26	68·4
Inappropriate-picture	31	90·9	34	85·0
Nonsense-picture	22	75·9	30	76·9

Table 2 shows the number of correct responses made after an interval of 28 days; the data are also given as percentages of the number of correct responses made in the last test session prior to the interval. Since the amount of data was small the differences were not statistically tested. It is evident, however, that after the retention period the greatest number of correct responses was made in the 'no-picture' condition, and the least number of correct responses in the 'appropriate-picture' condition.

DISCUSSION

In the present experiment the least favourable condition for learning to read was where each printed word was accompanied by a picture representing the same object as the word. Any adverse effect that the presence of a picture might have was small when the picture was unrelated to the printed word. The most favourable condition was where the word was presented without a picture of any kind. Moreover, these relationships held when training was massed or distributed in time, and also after a retention interval of 28 days. It appears, therefore, that the unfavourable influence of pictures on learning to read does not merely reflect the distracting effect that any extraneous stimulus might have; however, the results obtained with the 'nonsense-picture' show that such a distracting effect does, nevertheless, occur. The reason for the effect of the 'nonsense-pictures' is likely to have been the particular novelty of these stimuli not usually encountered in children's books.

Whether learning is retarded by the presence of pictures or not would seem mainly to depend on the relationship between the picture and the printed word. If both represent the same object, then in the course of learning the child can respond appropriately by attending only to the picture. The present evidence shows that the children did adopt such a strategy, since the 'appropriate-picture' condition resulted in the highest number of correct responses when pictures were present, i.e., in acquisition, and the lowest number of correct responses when pictures were absent, i.e., in testing.

In assessing the practical implications of the results, it is pertinent to consider to what extent the experimental treatments were representative of actual procedures used in the teaching of reading (cf. Kruglanski, 1975). Teachers extensively use combinations of pictures and words, often in the one-to-one ratio employed in this experiment. However, in practice the combinations tend to be varied, and not confined to any one of the word/picture relationships studied here. Samuels (1970) has pointed out that when an appropriate picture is present " the problem of getting the child to read the word is one of shift in stimulus control from picture to the printed stimulus " (p. 400). This problem does not, of course, arise if there is no picture, nor does it arise if the picture present is not specifically related to the printed word. Therefore, apart from what appears to be relatively minor attentional distraction, pictures of any general relevance to the text are not likely to be detrimental to learning to read (except, perhaps, for less able children; cf. Santostefano *et al.*, 1965). What is to be avoided is a direct equivalence between the picture and the printed text, especially in the case of the presentation of single words.

ACKNOWLEDGMENT—This research was supported by a grant from the Social Science Research Council.

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VISUAL PROCESSING OF STRAIGHT LINES IN DYSLEXIC AND NORMAL CHILDREN

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SUMMARY. Separation thresholds for groups of 26 dyslexic and normal children attending the first year of secondary school were obtained with pairs of identically-oriented and spatially-overlapping straight lines presented at orientations varying from zero to 90 degrees. The dyslexics as a group had about 10 to 15 msec longer separation times than normals. In a second experiment single straight line contours were preceded by an homogeneous light mask. Dyslexics required longer stimulus exposures for detection than controls. It is suggested that the present results are compatible with the view of a developmental lag in the visual information processing of dyslexics.

INTRODUCTION

INFORMATION processing concepts have provided a framework for the investigation of reading disability (Young and Lindsley, 1970). The associated methodology and techniques have been adopted to investigate temporal parameters of storage and transfer differences between reading disabled and normal children at early stages of visual processing (Stanley, 1975; Stanley and Hall, 1973a, 1973b).

Stanley (1975) and Stanley and Hall (1973a), have argued that the initial visual persistence or visual information store (VIS) duration is of the order of 30 to 50 per cent longer in dyslexics than normals. They presented their dyslexics and control groups with two-part stimuli at varying interstimulus intervals (ISI) between the parts. The subjects' separation threshold was reported as the ISI at which the display was first reported as not consisting of a composite figure and the dyslexic group required longer ISIs than the controls. Such results were taken to indicate that reading disabled children have a longer sensory storage than controls for visually presented material.

A recent study by Preston *et al.* (1974) extends the implications of Stanley's work by suggesting that the threshold for perception of visual stimuli is higher in dyslexics than same age normal readers and younger normal readers. The mean threshold for identification of consonant-vowel-consonant words for their reading disabled group was 53·33 msec compared with 20 msec for a group of same age normals and 46·7 msec for younger normal readers. As their study did not include any non-letter visual stimuli, no decision can be made as to whether the results primarily reflect perceptual or cognitive variables.

In the experiments reported in this paper, simple straight line stimuli were used in an attempt to reduce any effects of cognitive linguistic variables on perception. Separation thresholds for groups of dyslexics and control children were obtained with pairs of identically oriented and spatially overlapping straight lines presented at orientations varying from vertical to 90 degrees. A second experiment compared differences between the two groups on a detection threshold task.

EXPERIMENT 1

Sample.

26 children were selected from three suburban secondary schools, each of which has a remedial reading class. The criteria for selection of the dyslexic

group were: (*a*) a reading disability of 2·5 years or greater below chronological age on a standard reading comprehension test; (*b*) performance at age level or above on Progressive Matrices 38; (*c*) classroom performance in other subjects at average or above according to teachers' ratings; (*d*) no gross behavioural problems; and (*e*) no known organic disorders. The control subjects were not attending remedial classes, did not differ significantly from dyslexics on Progressive Matrices 38 and performed at comparable levels on other subjects as determined by teachers' ratings. All subjects were drawn from the first year intake; the reading disabled group having a mean age of 12·37 years and the control group 12·32 years. There were 10 males and three females in each group.

Stimuli. The stimuli were straight lines constructed from white tape, 75 mm long and 2 mm wide, fixed to a black background. Each line sub-tended a visual angle of 3° 15′ by 12′. The stimuli were presented in pairs, each pair being of the same orientation and spatially overlapping. The spatial overlap of the line stimuli was achieved by presenting one line in one channel and the other line in the second channel of the tachistoscope, ensuring identical location in each channel.

Apparatus. The pair of stimulus lines were projected from separate fields of a three-channel tachistoscope (Scientific Prototype, Model GB). The third channel consisted of a black field with a small red fixation light positioned in the centre of the stimulus presentation area. This third field was continuously illuminated during the experimental sessions. Each of the three fields was matched for space average luminance at approximately 2·57 cd/m^2.

Procedure. The subject's task was to judge whether one or two lines appeared on a given presentation. An experimental session consisted of five blocks of trials with each block representing a different orientation of the pair of lines. The angle of presentation was set at vertical, 22°, 45°, 67°, and horizontal. The sequence of presentation was randomised for each of the reading disabled children and this was matched within the control group. The stimuli were presented for 20 msec each with the ISI as the dependent measure.

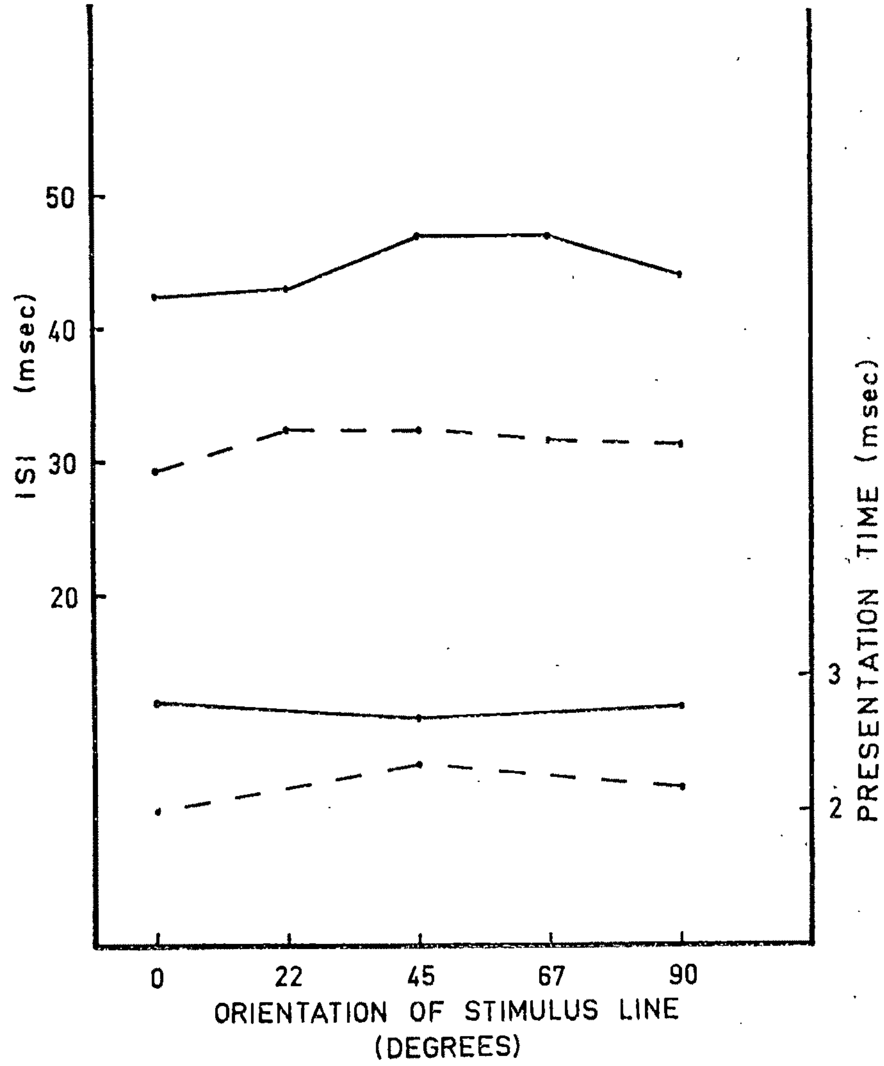
For each orientation there were six 'target' trials in which the identically oriented lines appeared sequentially separated by a given ISI value and six 'catch' trials in which the lines were presented without an ISI. The order of target and catch trials randomised at each ISI within a block of trials. A separation threshold (i.e., judgment of *two* lines appearing) was accepted at the ISI value at which the child gained 75 per cent accuracy in discriminating catch trials (one continuous line) from target trials (two lines separated by ISI). If, at a given ISI value, the child was more than 75 per cent accurate on the initial trial, the ISI was decreased until accuracy was 75 per cent or less. The ISI was increased over trials if responses were initially less than 75 per cent correct. Increments and decrements of ISI were made in 5 msec steps. Starting values for each child were determined by preliminary testing, and they were tested using binocular vision.

RESULTS

At each orientation of the stimulus lines the dyslexic group required a longer ISI than normals to report accurate stimulus presentations. This is clearly shown in Figure 1 which compares the mean separation thresholds between groups at each orientation used. An analysis of variance of the data yielded a significant difference between dyslexics and normals $F(1,24)=9{\cdot}94$, $P<{\cdot}01$; significant orientation differences $F(4,96)=5{\cdot}50$, $P<{\cdot}01$) and non-significant interaction.

FIGURE 1

MEAN SEPARATION ISIs AS A FUNCTION OF ORIENTATION ARE DEPICTED IN THE UPPER TWO TRACES.



Mean stimulus presentation times are depicted in the lower two traces. Solid lines indicate the performance of dyslexics, broken lines that of controls.

Scheffé test for multiple comparisons (Edwards, 1968) showed no significant differences between orientations within the normal reading group. For the dyslexic group, vertical and 20° were both significantly different from 45° ($P < \cdot 05$); vertical was also significantly different from 67° ($P < \cdot 05$); but no other differences reached significance.

EXPERIMENT 2

Sample.

The same children participated in Experiment 2 after having completed Experiment 1.

Stimulus and Apparatus. The mask consisted of an homogeneous light projected from one channel of the tachistoscope. The target was a single straight line as previously described. The channel from which the mask was projected also contained the fixation light. The masking field had a space average luminance of approximately 8·57 cd/m^2 and the target of 2·23 cd/m^2.

Procedure. In order to make the target more difficult to detect a forward masking design was used. The mask was presented for 55 msec and followed immediately by the target line. Presentation time of the target was the dependent measure. The orientation of the line was set at vertical, 45°, and horizontal. This was randomised across children in the dyslexic group and was matched within the control group. A similar method of target and catch trials as outlined in Experiment 1 was used in this experiment. At each orientation, for a given presentation value, the target line was present in half of the trials and the masking light alone for the other half. The time of presentation was varied in 1 msec steps until a 75 per cent accuracy rate was gained.

RESULTS

For each of the orientations used, the dyslexic group required longer presentation times than the normals to report the target's presence. The lower traces of Figure 1 present the mean detection thresholds for the two groups at each orientation. An analysis of variance indicates a significant difference between groups, $F(1,24)=4{\cdot}53$, $P<{\cdot}05$, non-significant orientation differences and non-significant interaction.

DISCUSSION

The major concern of the two experiments reported above was the separation and detection threshold differences between the reading groups. In the first experiment the longer ISI required by the dyslexic group presumably reflects the extended time needed for the VIS representation of the preceding stimulus to fade. This explanation is derived from studies of the ' psychological moment ' by Eriksen and Collins (1967; 1968) and underlies the previous work of Stanley (Stanley, 1975; Stanley and Hall, 1973a). As can be seen from Figure 1, the dyslexics as a group have about 10 to 15 msec longer separation time than normals. When these differences are expressed as percentages of the control group the longer durations range from 32 to 47 per cent. The higher separation thresholds of dyslexics when using simple straight line stimuli thus supports the earlier findings of Stanley as reported above. The longer visual persistence of the dyslexic group is not a function of relative stimulus complexity but rather appears to represent a characteristic difference in temporal processing of visual information.

The masking task involved the threshold detection of a target line. The lower traces of Figure I indicate that the reading disabled group required longer times than the normal readers to detect the target line. Given the earlier claim that visual persistence is greater in dyslexics than normals, then greater persistence of the mask for the dyslexics could account for their higher masking threshold.

In the light of reported orientation discrimination defects in poor readers (e.g., Silver and Hagin, 1970) it is of interest to note the lack of interaction between groups and orientation. Only in Experiment 1 were orientation differences significant and these were confined to within the dyslexic sample. In general no orientation differences for perceptual or memory processing were found between the groups. This would appear to indicate that weaknesses in this area are due to cognitive discrimination (knowing ' right ' from ' left ') rather than actual visual processing.

The result of this investigation supports the notion of a developmental lag in dyslexic children. It has been shown that VIS duration decreases with age (Gummerman and Gray, 1972; Pollack *et al.*, 1969) and the rate of processing of visual information increases with age (Blake, 1974; Gummerman and Gray, 1972; Haith, 1971). To this extent the dyslexic child appears to receive and process visual information similarly to chronologically younger children.

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RESEARCH NOTES

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WAYS OF MAKING NUMBER JUDGMENTS AND CHILDREN'S UNDERSTANDING OF QUANTITY RELATIONS

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SUMMARY. 60 children, aged between 4 and 7 years were given problems designed to assess their understanding of number invariance involving numbers of objects within their subitizing range, numbers outside their subitizing range but within their counting range, and large numbers they were not allowed to count. The results indicate that number invariance is initially developed for small numbers and then extended into the counting range and beyond.

INTRODUCTION

The purpose of these experiments is to investigate possible relations between the methods of quantification available to children and their performance on certain tasks requiring an understanding of number invariance.

Piaget (1952) seemed to regard the understanding of number properties as dependent on the attainment of mental operations. He claimed that number concepts are arrived at by synthesis of the operations of seriation and inclusion, and that the ability mentally to cancel out transformations (reversibility) is essential to the maintenance of quantity judgments in the face of perceptual changes. This approach has been challenged by Bryant (1972), who argues that in his studies Piaget had confounded the effects of dependence upon relevant (one-one correspondence) and irrelevant (length) quantity cues with understanding of number properties. According to Bryant (1974) a crucial point about the acquisition of number competence is that children move away from dependence on relative codes (such as comparing lengths) toward absolute codes (such as one-one correspondence or counting). The evidence summarised by Gelman (1972), indicating that numerical abilities are developed initially for small numbers only, is consistent with such a view.

The most detailed theoretical model of the way in which methods of quantification may relate to invariance judgments is that of Klahr and Wallace (1973). They point out that studies of reaction times and errors in tasks requiring adults to report the number of items in a display typically show discontinuities at around $n=5$ and $n=30$. This leads Klahr and Wallace to introduce the idea of a quantification operator (a system used to generate quantitative symbols), and to distinguish three basic quantification operators: subitizing (to account for the rapid processing of numbers below 6), counting, and estimation (for large numbers and continuous quantity). They hypothesise that children develop these operators separately, and that by applying them they discover the conservation rules underlying invariance judgments.

On theoretical grounds Klahr and Wallace argue that these rules will be discovered initially from application of the ' subitizing ' operator. The ranges of possible application of the subitizing and counting operators overlap, so that the conservation rules can then be mapped onto the wider ranging ' counting ' operator. Finally they can be transferred to cover quantities that can only be estimated.

This theory seems to lead to a simple prediction, namely that young children's performance on number invariance tasks will be better when the materials are within their subitizing range than within their counting range, and better within their counting range than outside it. The present study investigates this possibility.

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METHOD

Experiment 1.

The subitizing and counting abilities of 20 children aged 5-0 to 5-11 (10 boys, 10 girls) and 20 aged 6-0 to 6-11 (10 boys, 10 girls) drawn at random from the classes of a local primary school were assessed, and they were then given a series of problems designed to test their ability to maintain a judgment about number relations in the face of a conflicting quantity cue. These problems were adapted from those described by Bryant (1972). Five trials were given with numbers within the child's subitizing range, five with numbers he could count but not subitize, and five with large numbers he was not allowed to count. These trials were given in two sessions and in random order. All the children were found to be able to subitize to four and count to 12.

Procedure.

(1) The child's subitizing level was assessed. Arrays of 0·8 cm diameter black spots on 15 cm × 10 cm white card were covered by the experimenter's hand and exposed to the child for a brief interval (as brief as possible). The arrays contained up to seven spots, set out in random configurations, and the child was asked how many spots he had seen. His subitizing level was taken as the highest number on which he made no mistakes after four trials, providing no mistakes were made with any of the lower numbers. The order of presentation of the different arrays of spots was randomised.

(2) The child's counting level was assessed. He was asked to count 12 wooden blocks.

(3) Invariance problems.

(*a*) Within the child's subitizing range. (Five trials). Four wooden blocks in one row and three blocks in the other were set out to the same length and in one-one correspondence, following the example of Bryant (1972).

" How many are there in this row? " (Pointing to one row).

" How many are there in this row? " (Pointing to the other row).

" Which row has more? "

The row with fewer blocks was then made longer than the other row: " Watch what I'm doing. I'm only spreading them out? " " Which row has more now? "

(*b*) Outside the child's subitizing range, but within his counting range. (Five trials.) Eight blocks were in one row and seven blocks in the other row, again with one-one correspondence between rows and equal length of each row. The procedure was the same as (*a*) except that the child was asked to count the blocks in each row before the transformation (" Count how many there are in this row ").

(*c*) Large numbers and counting disallowed. (Five trials.) Sixteen blocks were in one row and 15 in the other row. The one-one correspondence between rows and the ' hole ' were pointed out to the child until he could answer the question, " Which row has more? ", satisfactorily without counting. The same procedure as (*a*) was then followed.

In each case the initial spacing of 2 cm diameter blocks was one block every 3 cm. The transformed row was made about 10 cm longer than the other row.

Experiment 2.

This was similar to Experiment 1, but the procedure was more flexible as the subjects were children aged 4-0 to 4-11 from a local nursery school. Their subitizing level was assessed by the method described for Experiment 1, and two groups were formed:

Group A: The first 10 children found who were able to subitize to three or above.

Group B: The first 10 children found who were unable to subitize as far as three.

Procedure.

The counting level of each child was assessed by asking him to count groups of blocks, and five trials with each of three types of invariance problem were given in random order:

(*a*) With small numbers of blocks. Two blocks in one row and three in the other, or three in one row and four in the other if the child could subitize to four.

(*b*) Outside the child's subitizing range, but within his counting range whenever possible. The particular numbers of blocks in each row depended on how far that child could count. Children who could not count to five were given five in one row and four in the other. Almost all of group B fell into this category (see discussion).

(*c*) Outside the child's counting range. Again numbers depended on how far the particular child could count.

The questions asked and general procedure were as for Experiment 1.

RESULTS

Each instance in which a child maintained his judgment across the transformation was scored as 1, changes were scored 0. The results of each experiment, in terms of the percentage of trials in which children showed understanding of number invariance by maintaining their judgment across the transformation, are given in Tables 1 and 2.

TABLE 1

RESULTS OF EXPERIMENT 1.

		Percentage of trials on which invariance shown		
	Average subitizing level	Numbers within subitizing range	Numbers outside subitizing range but within counting range	Large numbers and counting prevented
Age 5 (N=20)	4·35	48	32	27
Age 6 (N=20)	4·60	94	83	76

TABLE 2

RESULTS OF EXPERIMENT 2.

		Percentage of trials on which invariance shown		
	Average subitizing level	Small numbers	Numbers outside subitizing range (but within counting range for Group A)	Numbers outside subitizing and counting ranges
Group A (N=10)	3·2	44	6	4
Group B (N=10)	1·5	20	2	0

For Experiment 1, a Friedman two-way analysis of variance shows that the effect caused by the different conditions is significant at the ·05 level for the 5-year-old children, and the ·05 level for the 6-year-old children. The overall effect of the different conditions on all subjects in Experiment 1 is significant at the ·01 level. However, it could be maintained that this is merely due to the within-subitizing-range condition producing a very different result to the other two conditions. In order to assess this possibility a Wilcoxon matched-pairs signed-ranks test was carried out on the differences between performance with numbers within the counting range (but outside the subitizing range) and performance with large numbers when counting was prevented. This proved to be significant at the ·03 level, so it can be said that the results from all conditions differ significantly.

A different approach was taken to the results of Experiment 2, where performance in both conditions involving numbers outside the children's subitizing ranges was so poor that possible differences between them were ignored. A Wilcoxon matched-pairs signed-ranks test showed that there are significant differences between the children's scores on the trials involving small numbers and the trials with numbers outside their subitizing ranges (for Group A significant at ·01 level, for Group B at ·05 level). The performance of Group A and Group B on the small number trials was compared by a Mann-Whitney U test and the superiority of Group A (able to subitize the numbers involved) was significant at the ·025 level (one-tailed test).

DISCUSSION

The technique used is not the same as that used by Piaget to investigate what he calls conservation of number. His experiments asked for maintenance of a relation of equality between two quantities across a transformation, whereas the present experiments require maintenance of a difference and its direction. The reason for using such problems is that findings can be integrated with the well-designed study of Bryant (1972); they are also easier to use with 4-year-old children, who seem to understand the term 'more' better than 'same.' None of the 5- or 6-year-old children had any difficulty in making correct judgments of the relative numerosity of the rows in one-one correspondence except when the numbers were large and they were prevented from counting, when some training was necessary for three subjects.

The results of the experiments are consistent with the views of Schaeffer *et al.* (1974), who view number development in young children as consisting essentially of the hierarchic integration of a set of definable skills. The model proposed by Klahr and Wallace (1973) is a precisely specified variant of this type of theory. The results provide support for the Klahr and Wallace model since the children showed understanding of quantity relations initially for small numbers within their subitizing ranges, then for numbers they could count, and finally for numbers that could not be counted. The developmental trend indicated by the percentage results is strong, since of the 60 children involved in both experiments, no one performed better on invariance problems in his counting range than in his subitizing range, and no one performed better on invariance problems when he could not count than when he could.

Although the technique used to assess children's subitizing ability may slightly overestimate this ability by allowing subitizing to be used in conjunction with some counting from a visual icon, it is sufficient for present purposes since it indicates how far a child can quantify quickly and reliably. It is the speed and reliability of subitizing that Klahr and Wallace see as being responsible for the initial development of number conservation and transformation rules within its range of operation.

Normally one-one correspondence is used as a quantity cue when the rows are in ranks, like soldiers. With small numbers in each row, however, adults can make use of one-one correspondence even when the rows are not in ranks. This means that the superior performance of children with the problems within their subitizing ranges may simply be due to this possibility of establishing one-one correspondence even after the transformation. In Experiment 2 this was put to the test by comparing the performance on small number arrays of children who could subitize the numbers involved (group A) and children who could not subitize the numbers involved (group B). The superior performance of group A goes against the view that the early development of number competence within the subitizing range is due only to the ease of establishing one-one correspondence or the smallness of the numbers.

Unfortunately the crucial question of the developmental relation of subitizing to counting cannot be answered by such experiments. Gelman (1972) and Bryant (1974) argue that subitizing can only be developed for numbers the child can count, whereas Klahr and Wallace (1973) maintain that initially subitizing precedes counting. In Experiment 2 nine of the ten 4-year-olds who could subitize to three or above could count to at least five, whereas only one of the ten 4-year-olds who could not subitize to three could count to five. This indicates that the relation of subitizing to counting is a close one, but does not specify what it is.

Although the studies reported here are only of limited scope, there is an important point at issue. The teaching of number in primary schools has been much influenced by the idea that it is essential for children to understand the ' logic ' underlying number properties. The possibility that this understanding may be more readily attained by the indirect method of practice in traditional number skills than by attempts at direct demonstration merits further study.

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A NOTE ON THE USE OF PEEL'S LOGICAL GAME FOR STUDYING CONDITIONAL REASONING IN CHILDREN

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SUMMARY. Peel's logical game was used with six groups of elementary school children (N=300). The method was used to study rules of implication and incompatibility. The implication rule mainly generated conjunctive or matching responses; the incompatibility rule evoked greater variety of response deriving from simple contrapositive strategies. Omission of the connective 'if' in a second experiment did not affect the pattern of responses. Overall there was little evidence of developmental trends in the data.

INTRODUCTION

The results of a number of studies into the development of logical operations, e.g., Taplin (1971), Taplin *et al.* (1974), Paris (1973), indicate that the ability to use conditional reasoning effectively does not emerge until late adolescence. These findings agree substantially with the earlier work of Inhelder and Piaget (1958), although, as Taplin *et al.* (1974) observed, it is not necessary to conclude that reasoning with conditionals becomes more logical with increasing age. An equally tenable conclusion would be that the meaning of logical connectives change with age and that reasoning at all ages is logical.

However, most experimental work involving formal verbal reasoning tasks has found little evidence of developmental trends up to the age of 12, although it could be argued that this was to some extent the result of using methods which would be highly artificial for younger subjects. Peel (1967), therefore, evolved a more 'natural' approach which required subjects to follow rules governing the draw of coloured counters in response to the draw of coloured beads. By this means he was able to study the interpretation of logical connectives used in operations of implication, incompatibility and disjunction. In a 'Forward Game' version the subject attempts to produce valid counter draws in the light of a rule; in the 'Reverse Game' he has to judge the validity of responses made by the examiner. Like most researchers Peel found that subjects tended to interpret an implication rule as a bi-conditional or equivalence. However, some older subjects in the sample of children aged 5 to 11 years (N=150) produced and accepted a full range of valid conjunctions. By contrast, in response to the incompatibility rule children over the entire age range produced conjunctions as logically defined, this being considered to be new evidence.

The present study reports data obtained from a larger study carried out with the aims of (*a*) replicating Peel's work, (*b*) developing the basic methodology and (*c*) observing the effects of psycholinguistic variations on the rules. These will refer to responses to conditional rules which require operations of implication and incompatibility. In a supplementary experiment the effects of omitting the connective 'if,' were observed.

SAMPLE

The sample consisted of 300 Canadian school children stratified by grade level into six groups of 50. Five schools in the Greater Victoria area were selected so as to form a representative sample of the elementary school population. Each school provided 60 children (five males and five females taken at random from the rolls for each of grade levels 1 to 6). No further information about the sample was available.

METHOD

The basic method to be outlined consists of two conditions of administration: (1) Forward Game, and (2) Reverse Game. As in Peel's original work these are used to study operations of implication and incompatibility.

Material: 40 coloured plastic beads and 40 coloured plastic counters (10 of each of colours red, blue, yellow and green) and shallow dish.

Procedure.

(1) *Forward Game.*

Rapport having been obtained, the subject is issued with the set of coloured counters, the experimenter retaining the beads. The dish is placed between experimenter and subject.

E. " Now we are going to play a game with these coloured beads and counters. I shall take a bead and put it in the dish and all you have to do is put in one of your counters. But all games have rules don't they? So, before each game I shall give you a rule about which counters you can play. Now the rule is, we may each pick any colour we like but in this first game, if I put in a red bead, you must put in a red counter."

Experimenter then makes the first draw of a predetermined sequence of 10 (Red, Red, Green, Blue, Red, Yellow, Yellow, Red, Red. Red), the subject's draws being recorded. After each pair of draws the dish is emptied. The procedure is continued for rules of incompatibility and disjunction.

Incompatibility. " We may each pick any colour we like but in this game *if* I put in a red bead, you are *not* to put in a red counter."

(2) *Reverse Game.*

E. " This time we are going to play the game the other way round. You will tell me the rule, draw the bead and tell me whether the counter I play is right or not." (In fact experimenter asked subject to repeat the rule from time to time, correcting where necessary).

Subject is given a set of 10 beads, duplicating the colours played by experimenter and is allowed to draw them in any sequence he chooses. After each play of a counter, experimenter can ask, " Is it right?" but normally subject is likely to give a judgment spontaneously without being asked and removes the beads and counters from the dish setting them to one side. Experimenter then records the truth or falsity of subject's judgments. The set bead and counter conjunctions for the Reverse Game are as follows (Beads in capitals):

Implication. RED-red, RED-yellow, RED-red, RED-red, RED-green, RED-blue, YELLOW-yellow, YELLOW-red, GREEN-blue, BLUE-red.

Incompatibility. RED-blue, RED-red, RED-green, RED-yellow, RED-red, RED-yellow, YELLOW-yellow, YELLOW-red, GREEN-yellow, BLUE-blue.

RESULTS

The conjunctions obtained may be classified under the following headings:

(*a*) red bead — red counter (R.r)

(*b*) red bead — non-red counter $(\mathrm{R}.\bar{\mathrm{r}})$

(*c*) non-red bead — red counter ($\bar{R}.r$)

(*d*) non-red bead — non-red counter (matching) ($\bar{R}.\bar{r}_1$)

(*e*) non-red bead — non-red counter (non-matching) ($\bar{R}.\bar{r}_2$)

TABLE 1

FREQUENCIES OF COUNTER DRAWS AND CORRECT JUDGMENTS WITH RESPECT TO NON-RED BEAD DRAWS UNDER IMPLICATION RULE.

	Forward Game			Reverse Game		
Conjunction	$\bar{R}.r$	$\bar{R}.\bar{r}_1$	$\bar{R}.\bar{r}_2$	$\bar{R}.r$	$\bar{R}.\bar{r}_1$	$\bar{R}.\bar{r}_2$
No. of draws (50×4)	200			100	50	50
Grade 1	0	192	8	4	50	3
2	0	196	4	7	50	1
3	3	197	0	7	50	3
4	0	196	4	6	50	2
5	1	196	3	2	50	4
6	0	175	25	6	50	1

6 grades, 50 subjects each grade. Total N=300

TABLE 2

FREQUENCIES OF COUNTER DRAWS AND CORRECT JUDGMENTS WITH RESPECT TO NON-RED BEAD DRAWS UNDER INCOMPATIBILITY RULE.

	Forward Game			Reverse Game		
Conjunction	$\bar{R}.r$	$\bar{R}.\bar{r}_1$	$\bar{R}.\bar{r}_2$	$\bar{R}$ r.	$\bar{R}.\bar{r}_1$	$\bar{R}.\bar{r}_2$
No. of draws (50×4)	200			50	100	50
Grade 1	57	9	134	37	30	37
2	56	14	130	40	22	39
3	60	14	126	43	21	42
4	66	1	133	42	22	40
5	67	10	123	42	20	43
6	66	5	129	48	20	48

6 grades, 50 subjects each grade. Total N=300.

However, since practically all responses to red bead draws were correct it is proposed, in the interests of brevity, to report data only for the subjects' responses to non-red bead draws, i.e. (*c*), (*d*) and (*e*). In the case of both Implication and Incompatibility the subject has to respond to four non-red bead draws and to judge the validity of counter draws to four non-red bead draws. It may be noted that under standard truth tables for

Implication and Incompatibility, conjunctions (*c*), (*d*) and (*e*) are valid. Tables 1 and 2, therefore, summarise both Forward and Reverse Game data for the Implication and Incompatibility rules respectively.

A general tendency for the Implication rule to be interpreted as Equivalence is evident in Table 1. It may be seen that in the Forward Game subjects overwhelmingly employed a simple matching strategy of responding with a counter of the same colour. Only four times in 1200 did $(\bar{R}.r)$ conjunctions appear and what might be considered the more obvious $(\bar{R}.\bar{r}_2)$ conjunctions were also infrequent. The Reverse Game data show that a small group of subjects at each grade level was willing to accept $(\bar{R}.r)$ draws but there was usually no consistency in this when non-matching $(\bar{R}.\bar{r}_2)$ draws were taken into account.

However, Table 2 data indicate that a much more varied response pattern was generated by the Incompatibility rule at all grade levels: in particular, there was consistent use and acceptance of the $(\bar{R}.r)$ conjunction. Even so, attention is drawn to the relative infrequency of the matching conjunction $(\bar{R}.\bar{r}_1)$ and the low percentage of acceptances for it (22·5 per cent) in the Reverse Game.

DISCUSSION

The above data fail to demonstrate any recognisable developmental trends even over a 6-7 year age range. In the case of Implication the results may therefore be at variance with Peel's finding, although his sample contained some older subjects. They are, however, in agreement with data from other work, e.g., Roberge (1972), Knifong (1974), and Paris (1973). In fact, the Paris study produced little evidence of age-related differences up to Grade 6 and it was noteworthy that responses to conditional rules (if-then) and bi-conditionals (if-then only) were indistinguishable.

Like Peel the present writers were intrigued by the variety of Incompatibility responses, speculating that operations more characteristic of formal operational thinking might be elicited from younger subjects by appropriate stimulus materials. However, a more cautious interpretation of these data is facilitated by the breakdown into matching and non-matching draws. As a result of this it becomes questionable whether, as Peel claimed, Incompatibility is construed as the logician defines it. Subjects appeared to use a contrapositive strategy, the rule being transformed into something like " you must not put in the same colour as me " with perhaps the additional " but if I do not play a red you can." The latter would account for the sizable minority at each grade level which gave $(\bar{R}.r)$ responses. The relatively small numbers of matching colour draws and correct matching draw judgments strengthen this point of view which was in many instances confirmed by clinical enquiry.

Understanding of ' if ' and ' if then.'

It was often noted that when repeating rules or stating rules for the Reverse Game, subjects omitted the logical connective ' if.' This occurred despite the heavy emphasis given to the word and led to the suspicion that subjects were coping with a difficult verbal task by discarding its most complex linguistic element. With a view to clarifying this therefore a further experiment was undertaken, the subjects being English children (N=60; 10 males, 10 females at each of age levels 9, 10 and 11). The Peel game was played under two conditions (counterbalanced). The first involved the administration of the procedure exactly as described; the second restated the Implication and Incompatibility rules omitting the conditional ' if.' There were virtually no differences between the data obtained under the two conditions.

This finding would substantiate the view that most subjects within the age range studied, interpret conditional rules in the Peel game in terms of simple conjunctive strategies and ' if ' does not therefore appear to convey an implication of causality. This is not surprising of course, as conditional reasoning poses considerable difficulties for adults, some of whom are inclined to dismiss valid responses as irrelevant. However, it could be that the nature of Peel's approach limits opportunities for more logical responses and that the technique requires a clinical type of administration for its most effective use.

CONCLUSIONS

Use of Peel's approach over the 6-13 year age range did not yield evidence of developmental trends in children's ability to carry out conditional reasoning. Implication rules provoked conjunctive or matching responses; Incompatibility rules generated more diversity of responses at each grade level but these derived from a simple contrapositive strategy rather than awareness of the full material logic of the situation. Omission of ' if ' from the rules in a second study did not affect the responses.

The method would prove suitable for clinical enquiry into understanding of logical connectives and more complex binary and ternary operations. Future developments might include a creative element as several children suggested variations upon the game. However, little is known about the generalisation of operations sampled this way and a useful area for additional work might be teaching of logical operations and their transfer to scientific problem solving.

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ASSESSING THE DEVELOPMENT OF STUDENT TEACHERS' ROLE CONCEPTIONS

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SUMMARY. Repertory grids were used to monitor the development of student teachers' conceptions of their professional roles. The students rank-ordered 10 role figures (e.g., *teacher, pupil, principal*) in terms of their degree of involvement in 19 different activities (e.g., instruction, testing, counselling) before any teaching experience and following each of three, two-week sessions of practice teaching in local schools. There were significant increases in the level of integration of their role conceptions as they gained classroom experience. At first, these students exhibited less integration than did experienced teachers; however, there was no difference after the students had completed six weeks of practice teaching.

INTRODUCTION

Kelly (1955, 1969) argues that an individual's personal construct system becomes progressively differentiated into independently organised sub-systems, each with its own range of convenience (cf. Adams-Webber, 1970). The basic assumption of this research is that teachers evolve specific sub-systems of interrelated constructs in terms of which they define their own pattern of involvement in routine professional activities such as instruction, testing, counselling, etc. These role sub-systems can be viewed as also having implications for how the various functions of the teacher role are co-ordinated with those of related roles (e.g., pupil, principal, librarian) within the school. In this study repertory grid technique (Kelly, 1955; Bannister and Mair, 1968) was used to monitor the development of student teachers' role sub-systems during their first six weeks of practice teaching. It was expected that there would be increases in the level of integration of their role sub-systems as they gained classroom experience. Also, Kelly's assumption that there is a high degree of specialisation among sub-systems within an individual's personal construct system implies that these changes would be specific to their teacher role sub-systems and would not generalise to other sectors of their construct systems.

METHOD

The principals of seven schools—randomly selected from all primary schools in St. Catharines, Ontario—individually completed the following repertory grid task. Each principal was shown 10 role titles: *teacher, principal, vice-principal, teacher, consultant, pupil, librarian, parent, remedial teacher, superintendent.* He nominated one individual who occupied each role in his school. Their names were recorded on separate cards, which were scattered on a table in front of the principal. He was asked first to indicate which figure was most involved in handling discipline problems. The card chosen was removed from the display, and he was asked to designate which one of the remaining nine figures was most involved in this function. This procedure was repeated until he had rank-ordered all 10 figures from most to least involved in handling discipline problems. Next, he ranked the same figures in terms of their degree of involvement in pupil promotion—and so on—until he had successively ranked them on the basis of their degree of participation in the 19 different activities (constructs) listed in Table 1.

The data elicited from each principal were arranged in a separate 10 column (figures) by 19 row (constructs) matrix (e.g., Bannister and Mair, 1968, p. 62). Table 1 reports the average Spearman correlation between the principals' rankings of figures on each construct and its level of significance. These data indicate fairly high agreement considering that they each ranked a different set of individuals. This suggests that they have similar conceptions of the functions of each role. A single coefficient of concordance was computed separately for each principal. This index, referred to from here on as the *integration score*, is a measure of the overall degree of intercorrelation among the 19 constructs (Ferguson, 1966, p. 225). Following Bannister and Mair (1968, p. 57), it was assumed that the correlations among sets of rankings of the same figures on different constructs reflect the extent to which these constructs are related psychologically for the subject (cf. Bannister and Fransella, 1966; Kelly, 1955, 1969).

TABLE 1

AVERAGE SPEARMAN RANK-ORDER CORRELATIONS BETWEEN PRINCIPALS' RANKINGS OF ROLE FIGURES ON 19 ACTIVITY CONSTRUCTS.

Construct	$r_{av.}$	P
1. Defining teaching objectives	·73	·001
2. Designing tests	·64	·001
3. Marking tests	·63	·001
4. Handling discipline problems	·70	·001
5. Pupil promotion	·62	·001
6. Budget spending	·74	·001
7. Referral to other staff	·61	·001
8. Writing reports on pupils	·40	·001
9. Organisation of timetable	·59	·001
10. Assessing effectiveness of learning programme	·68	·001
11. Assessing effectiveness of teachers	·62	·001
12. Controlling use of learning materials	·53	·001
13. Determining teachers' workloads	·65	·001
14. Determining what is to be learned	·61	·001
15. Participation in classroom learning	·51	·001
16. Participation in out-of-school learning	·55	·001
17. Deciding where learning occurs	·45	·001
18. Determining emphasis on reading, writing, maths, *etc.*	·54	·001
19. Determining emphasis on dance, singing, art, *etc.*	·53	·001

Next, 64 regular classroom teachers from the same schools individually completed the same repertory grid task. A single integration score was computed separately for each teacher. There was a significant correlation between the integration score of each principal and the median integration score of teachers in his own school (Spearman $r=0{\cdot}75$, $P<{\cdot}05$, one-tailed test). This suggests some interaction between the role sub-systems of principals and teachers within the same schools. However, a Kruskal-Wallis one-way analysis of variance revealed no significant difference between schools in terms of teachers' integration scores ($H=8{\cdot}35$, 6 df, NS).

Finally, 29 students were recruited from a practice teaching course in the College of Education, Brock University. All students who volunteered were included in the sample. None had previous teaching experience and all planned to become teachers. The same repertory grid task as that administered to the principals and teachers was completed by these students individually during the first week of the course prior to any practice teaching. They also completed it on three subsequent occasions: once following each of three, two-week sessions in which they were engaged daily in supervised teaching in St. Catharines schools. Each session was spent in a different school. As a control for the possible effects of repeating the same repertory grid format, an additional task was completed on each occasion. In this control grid the same 10 figures were rank-ordered successively on 15 interpersonal constructs previously elicited from the student using Kelly's (1955) method of triads. The order of the two grid tasks—experimental and control—was counterbalanced across the four occasions.

RESULTS

One integration score was computed separately for each one of these 232 grids. A Friedman two-way analysis of variance indicated significant increases in the students' integration scores across the four experimental grids ($\chi^2=15{\cdot}44$, 3df, $P<{\cdot}01$), and no significant change across the four control grids ($\chi^2=1{\cdot}10$, 3 df, NS). Wilcoxon tests revealed significant gains in integration scores from the first experimental grid (mdn $=\cdot 49$) to the second (mdn $=\cdot 51$; $z=-1{\cdot}69$, $P<\cdot 05$); no change from the second to the third (mdn $=\cdot 51$); and significant gains from the third to the fourth (mdn $=\cdot 55$; $z=-3{\cdot}20$, $P<\cdot 001$). Comparisons between the students' integration scores and those of the regular classroom teachers indicated that the students' initial ' base-line ' scores were significantly lower than those of the experienced teachers ($z=-2{\cdot}97$, $P<\cdot 01$). However, after six weeks of practice teaching there was no significant difference between students (mdn $=\cdot 55$) and teachers (mdn $=\cdot 54$).

DISCUSSION

These results support the hypothesis that there would be increases in the level of integration of the students' role sub-systems as they acquired classroom experience. Before practice teaching their integration scores were significantly lower than those of regular teachers, presumably because they lacked experience interacting with teachers and persons in related roles. However, during only six weeks in the classroom they developed role sub-systems which did not differ in terms of their level of integration from those of experienced teachers. This is consistent with the general assumption that individual teachers evolve specific sub-systems for construing their own pattern of professional activities in relation to those of persons occupying complementary roles within the school. The fact that there were no systematic changes in the control grids excludes the possibility that the increases observed in the experimental grids were due to the mere repetition of the same grid format. This also supports the second hypothesis that the expected increases in integration would be specific to constructs which are directly relevant to defining the teacher role and would not generalise to other sectors of their personal construct systems. Thus, these results are consistent with Kelly's (1955, 1969) argument that individual cognitive development involves both increasing differentiation between sub-systems and increasing integration within sub-systems (Adams-Webber, 1970; Salmon, 1970). They also provide further evidence of the construct validity of repertory grid technique as a method of measuring these progressive changes in the structure of individuals' personal construct systems.

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GEOGRAPHIC MOBILITY AS A VARIABLE IN EX-POST FACTO RESEARCH

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INTRODUCTION

Geographic mobility is an accepted part of people's lives. A great many studies today concern the relationship between geographic mobility and various adjustment measurements. A dependent variable often analysed in relation to geographic mobility is academic performance. Most studies (e.g., Larson, 1940; Tetreau and Fuller, 1942; Levine *et al.*, 1966) show a negative relationship between mobility and academic performance. In a review of studies within this field Schaller (1972) found that none of the 14 studies reviewed reported any data concerning academic performance *before* a residential move. This finding presents a serious objection to the customary *ex post facto* studies, since it is possible that the differences between control and experimental groups of children in school behaviour only represent initial differences between these groups. To meet this objection it is the prime aim of this study to test the hypothesis that differences in academic performance between children who had never moved and children who had moved once or several times before to a great extent stem from the fact that they perform differently prior to mobility.

METHOD

Data for this present study were taken from permanent record cards for 895 pupils completing ninth grade in the spring, 1972, in Göteborg, Sweden. 417 had been in the same school from grade 3 to grade 8, 398 attended two different schools and 80 attended three or more different schools. All subject marks from grade 3 to grade 8 were recorded. Beside the overall mean performance level special analysis was made on Swedish, arithmetic, English, arts, handicraft and gymnastics on each grade level.

At the time of school enrolment 93·3 per cent of the pupils who had always been in the same school lived in a complete family with both father and mother, as compared to the mobile group in which only 80·3 per cent lived in complete families. The mobile and immobile groups differed with reference to family composition in a highly significant way (χ^2=32·01, df=1, P<·01).

TABLE 1

MEANS AND STANDARD DEVIATIONS OF PERFORMANCE SCORES IN GRADE 8 FOR THREE GROUPS OF ELEMENTARY SCHOOL PUPILS DIFFERING IN THEIR GEOGRAPHICAL MOBILITY.

	Always in the same school (Gr I; N=417)		Attended two schools (Gr II; N=398)		Attended three or more schools (Gr III; N=80)		Significance		
	Mean	SD	Mean	SD	Mean	SD	I-II	I-III	II-III
Swedish	3·11	0·92	3·04	1·01	2·59	0·91	NS	P<·01	P<·01
Arithmetic	2·85	1·02	2·86	1·03	2·42	0·94	NS	P<·01	P<·01
English	2·82	1·05	2·92	1·05	2·45	1·07	NS	P<·01	P<·01
Gymnastics	3·14	0·99	3·05	1·03	2·76	1·06	NS	P<·01	P<·01
Handicraft	3·12	0·89	3·05	0·89	2·66	0·76	NS	P<·01	P<·01
Art	3·03	0·92	3·12	0·97	2·80	1·01	NS	P<·10	P<·05
Total score for ten subjects	30·21	7·24	30·03	7·61	25·55	7·02	NS	P<·01	·<·01

RESULTS

In the first analysis academic performance was compared for each of the three different mobility groups in grade 8. The results of the analyses are given in Table 1.

From Table 1 it is quite clear that there were great differences between the two mobile groups. The most mobile group showed consistently lower means in all comparisons, while none of the differences between means for immobile pupils and for pupils who had changed only once reached the ·05 level of significance. For three of the subjects, Swedish, gymnastics and handicraft the stable group had somewhat higher means, and for the remaining three subjects pupils who changed school once had somewhat higher means. When total performance scores were considered the difference between means was small and not significant. Pupils who changed school once during the elementary school years did not differ in any significant aspect in academic performance in grade 8 from pupils who had been continuously in the same school from at least grade 2 to grade 8.

When the comparisons included the most mobile group, all the differences except one were significant and in all comparisons the most mobile group showed the lowest academic performance.

On the basis of the obtained results one possible interpretation is that mobility has some negative effect on academic performance at least when pupils move twice or more in elementary school. There are also other ways of viewing the differences. Another possibility is to think of the differences in grade 8 as a result of differences during the first school years. Finally, it is possible that the differences are due to factors related to mobility.

To determine if the observed differences in grade 8 existed as early as in grade 3, before the first move occurred, analyses of performance scores were carried out in grade 3. English and art appeared first in grade 4 and therefore the analysis for these subjects is carried out in this grade. Means and standard deviations for the previously discussed three groups, the immobile group, the group who changed school once, and the group who changed school at least twice and the results of the testing of the differences between means are given in Table 2.

TABLE 2

MEANS AND STANDARD DEVIATIONS OF PERFORMANCE SCORES IN GRADE THREE BEFORE THE FIRST MOVE FOR THREE GROUPS OF ELEMENTARY SCHOOL PUPILS DIFFERING IN GEOGRAPHICAL MOBILITY.

	Always in the same school (Gr I; N=417)		Attended two schools (Gr II; N=398)		Attended three or more schools (Gr III; N=80)		Significance		
	Mean	SD	Mean	SD	Mean	SD	I-II	I-III	II-III
Swedish	3·25	0·89	3·18	0·91	2·67	0·99	NS	$P<{\cdot}01$	$P<{\cdot}01$
Arithmetic	3·23	0·89	3·10	0·92	2·76	0·88	$P<{\cdot}05$	$P<{\cdot}01$	$P<{\cdot}01$
English	3·09	0·90	3·13	0·99	2·67	0·93	NS	$P<{\cdot}01$	$P<{\cdot}01$
Gymnastics	3·17	0·67	3·21	0·69	2·97	0·81	NS	$P<{\cdot}05$	$P<{\cdot}01$
Handicraft	3·00	0·73	2·97	0·74	2·85	0·80	NS	$P<{\cdot}10$	NS
Art	3·08	0·67	3·09	0·73	2·92	0·76	NS	$P<{\cdot}10$	$P<{\cdot}10$
Total score for ten subjects	31·55	4·93	31·56	5·17	27·97	5·39	NS	P ·01	P ·01

The outcome of the analyses in Table 2 reminds one to a high degree of the results presented in Table 1. Pupils always in the same school and pupils who attended two schools had about the same starting positions in total academic performance level. In one subject, arithmetic, the immobile group had a significantly higher mean in grade 3.

For the remaining subjects the differences were about as large in grade 3 as in grade 8. For all subjects the mobile group had somewhat higher standard deviation. This was also true for total performance score. Pupils with three or more school attendances differed significantly from the other pupils in academic performance. The means were significantly lower in all three theoretical subjects and also in gymnastics.

From Table 2 it is clear that the most mobile group has a less favourable academic situation than the other groups, not only in grade 8 but also in grade 3, before the first move. These results may serve as a warning against drawing hasty conclusions. Studies on mobility and academic performance are usually based on *ex post facto* data, and therefore it must be noticed that the differences observed after a change probably existed in many cases also before it. Without controlling for this factor it is impossible to decide how much of the differences after a move is due to factors related to change of school and how much is due to differences between groups *before* the move. There is considerable support for our hypothesis that the differences in academic performance, after a move, between pupils who move and pupils who do not move, depend to a great extent on the fact that these groups differ in their performances before the move.

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BOOK REVIEWS

BERRY, P. (Ed.) (1976). *Language and Communication in the Mentally Handicapped.* London: Edward Arnold, pp. viii+215, c. £7·50, p. £3·50.

This is a collection of 11 articles, most of which describe, and discuss the practical implications of, recent research into language in the mentally handicapped child. The majority of the contributors are, or have been, working at the Hester Adrian Research Centre, Manchester University. Other contributors are a speech therapist, a Cambridge researcher and a lecturer.

The book is intended to have a wide appeal. The editor states, in his preface, that it is " for all professionals involved with the mentally handicapped child "; the introduction by Mittler suggests that it is primarily for teachers; and in the final chapter the book is described as a potential " compulsory textbook on all causes (sic) for teachers of the mentally handicapped " (p. 207). Apparently diverse as these claims are, I would judge that they are reasonably accurate, although it will appeal most to teachers and educational psychologists.

There is little previously published material in the book and it contains a plethora of explicit suggestions for further research (some of which could well be carried out by teachers), detailed descriptions of assessment techniques and teaching ideas. In addition, with one or two exceptions, the contributors write in lucid uncluttered language avoiding the abstruse terminology associated with linguistic analysis. The result is a book which is, in the main, very readable.

In the first chapter Mittler defines the range of skills involved in language, and describes existing assessment techniques, covering only briefly the more traditional measures (e.g., ITPA, EPVT, etc.) which he has so adequately covered elsewhere. His main emphasis is on the ways in which the teacher can use observational skills, self assessment, and awareness of classroom interactions to monitor systematically children's progress. There is an abundance of ideas for teachers here, many of which are reviewed in more detail by other contributors later in the book.

Three further chapters relate to assessment techniques. In the first Wheldall describes research using the sentence comprehension test (SCT) in the measurement of the child's ability to grasp sentences of increasing length and complexity. The frustrating thing to the practitioner, teacher and psychologist, is that although the SCT has been around in experimental form for 10 years, it is not yet published. Berry describes how " elicited imitation " (repetition of a presented utterance) can be used as an assessment technique, and in a later chapter, with Taylor and Conn, shows how language programmes based on this form of assessment can be constructed. This is a relatively novel, and very promising method for use by teachers. Particularly impressive is the way in which it is shown how much information can be gleaned from response error patterns. In this section, the final chapter describes how a survey of language of ESN(S) children in Manchester. The questionnaire is included in full and if it were used for prescriptive purposes rather than as a record, it could be most useful to many schools.

The second section contains three chapters, all of which describe research on language teaching programmes. One of these, written by Fenn, is a clear and persuasive argument for the use of structured language programmes rather than verbal enrichment. It is a pity that yet again the method of linguistic assessment used in her research is not readily available, and involves a fairly deep knowledge of grammatical analysis.

Three further chapters concerned with analysis of teacher language and methods of analysing child/child and child/parent interaction consist of research reports. These are stimulating and likely to provoke further research into the functions of language and the optimal situations for eliciting language, but they are less likely to be viewed as immediately germane to the work of the teacher in the classroom, mainly because, as the authors point out, few practical implications can yet be educed.

The final chapter discusses language in the context of teacher training and although of interest to a tutor, does not readily cohere with the rest of the book.

There are a few typographical errors in the text, and one error in the key to figure three in Chapter 2 (p. 46), which shows results exactly the reverse of those described in the text.

From the point of view of a teacher or educational psychologist, well over two-thirds of the articles in this book are essential reading and unequivocally live up to Mittler's claim (p. 2) that the book " represents one of the first attempts to relate research to practice."

IAN BERRY.

CLEARY, A., MAYES, T., and PACKHAM, D. (1976). *Educational Technology: Implications for Early and Special Education.* London: John Wiley, pp. x+191, £6·75.

This is one of the best short, comprehensive guides to the various facets of educational technology so far published. In spite of the sub-title, very little of the book is devoted exclusively to young or handicapped children. It embraces all ages, including university students, and can be read with profit by all concerned with education.

The authors' definition of ' educational technology ' is commendably broad and covers " the overall methodology and set of techniques employed in the application of instructional principles." Thus: " The teacher, who rewards a child by smiling and saying ' Well done ' when the child performs some act that conforms with the teacher's intention, is employing educational technology just as if the child was responding to a fully automated system."

The background to this view is sketched in with reference to developments in audio-visual aids, cybernetics and psychology, and includes reference to the work of such people as Pavlov, Thorndike, Pressey and Skinner. The ideals of the Learning Village, established at Kalamazoo by Ulrich and his colleagues, is also outlined.

Three excellent chapters are devoted to the hardware aspects of educational technology, but always keeping educational and psychological principles in mind. These chapters, covering automated systems, system components, and computer applications, are extremely well illustrated with photographs and diagrams. A most useful table summarises the characteristics of eight major systems including the Touch-Tutor, which was designed by Cleary and Packham some 10 years ago. This apparatus has proved helpful in training pre-school children and the mentally handicapped in acquiring visual discrimination skills.

A chapter on organising resources includes a discussion on the way the Open University has applied a systems approach to education, and also considers criteria of success. After drawing attention to the need for interdisciplinary collaboration in educational technology, the authors suggest that one way of achieving this would be to set up a central agency. Having said this, it is rather surprising that they do not discuss the relevance of the Council for Educational Technology for the United Kingdom (CET), which has its offices in London and which was responsible for inaugurating the National Development Programme in Computer Assisted Learning. The latter has funded some 40 projects in various parts of the country, including at least one in the computer assisted teaching of remedial reading. As CET superseded the National Council for Educational Technology (NCET), which was established as a result of the Brynmor Jones Report on *Audio-Visual Aids in Higher Scientific Education* (1965), a brief appraisal might have been made of this central organisation, even allowing for the time required to print the book. This latter consideration may possibly account for the fact that few recent references are included in the bibliography (fewer than 30 from a total of over two hundred were published after 1971, when *Aspects of Educational Technology V*, edited by the same authors, appeared).

A few technical developments have occurred since this book went to press, one being the introduction of a video-cassette recorder capable of replaying single frames, but what is the future of educational technology likely to be? The authors refer to Smith's (1974) paper on the future of psychology, and note that it makes the prediction that computer learning and slide-tape packages will be standard modes of education soon after the turn of the century. Be that as it may, the book under review gives a good historical perspective on the subject and prepares us for the future, whatever it might hold.

GEOFFREY LEYTHAM.

CONNELL, W. F., STROOBANT, R. E., SINCLAIR, K. E., CONWELL, R. W., and ROGER, K. W. (1975). 12 *to* 20: *Studies of City Youth.* Sydney: Hicks Smith, pp. 342, n.p.

This book is a report of a large-scale study of Australian adolescents. As the authors state it: "The primary purpose of the study is to describe the characteristics of Sydney teenagers as fully as possible." To this end they have gathered, from a sample of 8,000 high school students and 1,100 teenagers who have left school, a mass of information concerning interests, attitudes and values, relationships with parents, friends and teachers, and evidence on self-image, aspirations and intellectual changes. The book is primarily a descriptive one. Little attempt is made to take up theoretical issues, and too few attempts are made to compare these data with evidence gathered from similar studies in the UK and US. That having been said, however, there is a refreshing aspect to the book which differentiates it from many of the other straightforward studies of adolescence. All of the authors work in Sydney University's Department of Education, and they have tried throughout the study to select issues which will be relevant to education, and in discussing their findings to point up the links between adolescent development and the school setting.

The study is a cross-sectional one, and too little allowance is made for the methodological limitations inherent in such a design. Nonetheless, there is a very considerable amount of extremely valuable information here, and anyone who is at all interested in adolescence will certainly find that the book repays careful reading. Of the many worthwhile things perhaps two may be selected as illustrative of the general approach. Cognition is one of the areas of development upon which the authors have chosen to concentrate, and they have included a relatively simple analysis of social class and IQ. In addition though, they have also incorporated the study material developed by E. A. Peel in his work on adolescent judgment. By so doing they have been able to provide a much-needed exploration of the development of formal operations in a large urban sample. The data show clearly what has been long suspected. Formal operations are only achieved by a small minority of the adolescent population, even at school-leaving age. The other example which may be selected to whet the appetites of some readers is Connell *et al.*'s imaginative approach to the adolescents themselves. Those who carried out this study clearly believed that teenagers were worth talking to, and were genuinely interested in what young people had to say. The last chapter is an account of the findings of one small aspect of the project, in which teenagers at different ages were asked to plan, on a blank timetable, their own school curriculum. The results are well worth reading!

There is no doubt that this book has limitations. Many of the data are poorly presented. A conceptual approach is lacking, and methodological issues inherent in such a large study are glossed over. On the other hand, the book should perhaps be judged simply for what it is: a descriptive account of an important study of Australian city youth, containing much valuable and interesting material. It has not the breadth and will never achieve the status of Douvan and Adelson's *The Adolescent Experience*, but it should certainly be consulted by all those involved in adolescent research.

JOHN C. COLEMAN.

DISSINGER, A. J., and ARNOLD, C. R. (Eds.) (1975). *Studies in the Psychological Foundations of Exceptionality*. Monterey, Calif.: Brookes/Cole Publishing Co., pp. vi+316, $9·95.

According to the editors this unpretentious book of readings (i) " is designed for use in undergraduate courses in psychology, education, and child development in which the study of exceptionality is emphasised," (ii) presumes " knowledge from one or several basic text-books on exceptionality " and has as its foremost objective to supplement these, and (iii) has as its secondary objective " to introduce the reader to the research process as one means of acquiring knowledge about exceptionality." Part One, by the editors, endeavours in a dozen pages to cover the conventional methodological ground to help ' the potential consumer of research ' to acquire at least an intuitive level of understanding of the research process. This appears to assume that the students concerned will not have acquired the necessary technology from a standard course in experimental method and statistics, but in that event a somewhat simpler introduction to the critical reading of the different types of articles that follow would have been more appropriate.

The main text consists of 44 papers from 21 journals, but half from only five of these, and over 80 per cent from the years 1969-72. These articles are grouped into four parts—giftedness and mental retardation, physical handicaps and learning disabilities, cultural and social differences, and communication disorders—with 10, 8, 13, and 13 papers, respectively. All of them deal with aspects of the main topics of a course appropriate to educational psychologists or clinical psychologists specialising in work with children.

The quality of a few of the papers is guaranteed by their authorship—notably Torrance and Kogan in separate follow-up studies in creativity, Hess and Shipman on early socialisation of cognitive function. The rest vary widely in scope, and no less widely in methodological sophistication and technical presentation. Jones's paper, for example, on cutaneous and kinaesthetic localisation of blind and sighted children is very good; Bloch and Goodstein provide a devastatingly critical (or profoundly pessimistic?) review of 10 years' research on personality and adjustment in relation to the main functional pathologies of speech, including stuttering; while Beagley and Wrenn's report of clinical follow-up of normally hearing children with delayed speech could have been interesting, but is muddled and poorly organised. It is, indeed, hard to understand why some of the articles were reproduced, unless the editors took the cynical pedagogic view that the learner ought to develop his critical teeth on a sample of poorly argued and untidily designed investigations.

This collection of readings is generally inappropriate to the undergraduate work of most British departments of psychology, and to all colleges of education. It presents material that could be useful in the context of some post-graduate professional courses where some of the articles would be suggestive of interesting lines of research. Others provide useful ' action research ' discussions of ideas that are relevant to classroom and clinical practice in dealing with the maladjusted, the retarded, and the problems of sensory handicap. In the present financial climate, it might well come low on the list of library priorities.

GEORGE SETH.

ERASMIE, T. (1975). *Language Development and Social Influence.* Linkoping University, pp. 317, n.p.

Translations of research reports are not always easily read, but this book is a serious study worth consideration. The main argument is that the effects of schooling on language development may not act to reduce differences related to social background but rather to enhance them.

The first three chapters are devoted to a review of theoretical positions in the areas of sociolinguistics and language development as related to education. In particular, Erasmie is concerned to draw a distinction between combinations of sociolinguistic with behaviourist and with mentalist viewpoints. In the former case the solution to difference is seen as additional or compensatory learning, while in the latter it is seen as new code learning through the alteration of social relations. At their extremes these represent reform and revolution, but Erasmie would like to see a moderate strategy of reform by the steady change of social structure. The author's commitment to social action as well as to research is seen in such statements as, " The aim of sociolinguistics is to find explanatory models and remedial measure programmes, too. It tries to even out social inequalities resulting from a lack of positive social influence . . . " (p. 20). Not all sociolinguists would take this view. Also evident is his difficulty with the problem of value judgments in relation to language differences. He disapproves the use of terms implying 'good,' but fails to examine the implications of the epithet 'positive.' This uncertain position is shared by many who try to come to grips with questions of language and social background.

Erasmie's own research studies of 1963 and 1972 are reported in the next four chapters. They comprise (*a*) descriptions of the language abilities of a group of children first at the Swedish pre-school stage and later during their upper school years in comprehensive schooling; (*b*) examination of the predictive value for language skill of factors such as social group, parental education, income level, intelligence and school grades in various subjects; and (*c*) comparisons between the language abilities of social groups at both stages of schooling, and comparisons between the effects of the various factors at the two stages. Since the work spans a decade it is hardly surprising that during this time sociolinguistic research relating to education has seen changes in measures of linguistic ability and social grouping and changes in research techniques. Work rooted in the linguistic measures and multivariate analysis techniques used by Erasmie may seem to some to be outmoded, but both seem to be too robust to be easily written off. Traditional measures of language ability, such as word counts, length of sentence, parts of speech and vocabulary are combined by Erasmie to yield two dimensions (quantitative and qualitative) which closely resemble Thurstone's measures of fluency and verbal ability. Given these, it is scarcely surprising in view of American and British research that socio-economic group differences are found, but no real relationship with Bernstein's concept of sociolinguistic codes is discernible. One very important question must be asked about the comparisons between age levels, however, since the younger children supplied spoken language while the older supplied written. If different language skills were tapped how valid is the direct conclusion that schooling enhanced language differences? These differences of mode may also have affected the predictive value of the various background factors, for it is reported that at the younger age level intelligence was the most powerful predictor, while later intelligence and school grades predicted well. At both stages these were much more powerful than social group or other characteristics of parental education and income, but of the latter maternal education seemed the more important.

Erasmie, not liking to consider too closely the implications of the intelligence variable, is inclined to attribute this effect also to environment differences associated with social groups. He is firm, however, in his conclusion that schooling did not reduce the differences in language ability related to background, but did enhance them. His discussion, therefore, takes him into a consideration of models of schooling in which he approves the 'dialogue' model of the Swedish pre-primary school as advocated in the Hellstrom Report, and is critical of the kind of comprehensive schooling which has in his view failed to achieve the greater equality which it was intended to promote.

This work needs careful reading, and any conclusions drawn from it must rest in consideration of the nature of schooling and society in Sweden, and on the nature of the measures and statistical analyses used. It is of interest for the student of comparative sociolinguistic and educational studies rather than of psychology in education and does not appear to be written for the more general reader.

HAZEL FRANCIS.

FEATHER, N. T. (1976). *Values in Education and Society.* New York: Collier-Macmillan, pp. xv+350, £9·95.

This is a report of the large-scale inquiry into human values carried out at Flinders University in Australia between 1968 and 1974. Among the topics which were studied from the point of view of values were educational choice, adjustment to school, inter-school differences, the generation gap, the characteristics of activists and delinquents, and problems of culture and acculturation.

The book exhibits the Rokeach values paradigm in extended use. The main research instrument was the Value Survey, in which the respondent is asked to rank two lists of 18 items in order of personal importance. Like most instruments in this area, this test has a very wide applicability, but rather low reliability. (The median figures reported here were 0·63 for 'terminal values,' and 0·56 for 'instrumental values'). Feather's work has consolidated that of Rokeach in several ways. He has shown, for example, that similar results are obtained regardless of whether the items are ranked , rated, or subjected to comparison in pairs; and his correlational analysis (of the two sets of items taken separately), confirms that the 'values' are not easily reducible to a smaller number. Among Feather's innovations are the use of analysis of variance rather than non-parametric methods in making value comparisons, and the use of the Survey to test the values which people attribute to other groups or to institutions.

Possibly the most valuable parts of the book are the first and last chapters, where the author relates values to such topics as attitude theory, motivation, and especially cognitive psychology. The central chapters which report the various investigations into values are, however, relatively dull reading. It is not easy to see how measurements of 'average value systems' and correlations of value rankings with other variables, can have much part in illuminating the realities of the individual or the social world. After reporting such measurements the author generally employs one of two tactics. The first of these is to show how the data support expectations held on the basis of other research, commonsense, or intuition. For instance, the fact that adolescent boys and girls rank 'true friendship' highly is handled in this way. The second tactic applies when the findings are unexpected: it is to make *ad hoc* speculations about how the results could have come about. An example of this is the discussion of the curious fact that juvenile delinquents give a high ranking to 'cleanliness' and 'national security.'

Research of this kind thus remains largely on the surface, and does not greatly enrich the understanding, either at a psychological or sociological level. Measurements made with the Value Survey are general enough to be related to data from many sources, often in an intriguing and thought-provoking way; yet they seem to offer a curiously blurred representation of reality, to confuse and obscure almost as much as they reveal. Moreover, in some cases methods of inquiry are already available which are far more powerful, and which could be applied to the same topics. For example, the study of school adjustment, and the whole subject of what Feather calls 'person-environment fit,' could have been made using the well-articulated methods of rôle theory, a topic which (surprisingly) is not given any place in this research.

The book is competent, thorough, and clearly written. It is an admirable summary of work on values within the Rokeach paradigm, showing both the strengths and weaknesses of this approach. It is now necessary for the values domain to be explored with more precision and detail: here Feather significantly points to some of the directions which further research might take.

TOM KITWOOD.

GELFAND, D. M., and HARTMANN, D. P. (1975). *Child Behaviour Analysis and Therapy*. New York: Pergamon Press, pp. xii+332 $8·00.

The title of this book is misleading—it is not a book about children—it is, in fact, a students' primer in behaviour modification techniques. It is written very clearly and provides a step-by-step account of how to plan, carry out, record and write up a project so that a beginner, by following the detailed instructions, cannot go wrong. He is given advice on how to choose a 'target behaviour,' which techniques are appropriate, how to assess and present results and is even reminded to say thank you in a section headed " Promoting Good Will."

In spite of its clarity and competence, it is a dangerous book. The introduction requires the student to read a textbook on behavioural principles before attempting his first project and frequent references are made to theoretical considerations, but although there is an emphasis on observation of the child/client " to identify probable sources of behaviour " the student apparently requires no knowledge, experience or skills in assessing the normality or complexity of children's behaviour, let alone in working with actual children. On page 110: " If you are unfamiliar with the ways of children and do not know how best to approach them, observe teachers and others . . . they might also be willing to offer you some good suggestions . . . " On page 175 the unskilled student is advised that if a child is too disruptive to attend to a " shaping programme designed to teach him imitation, object identification, speech or some other necessary skill," a mild punishment procedure might be used. The student, however, has no experience of assessing whether the programme is within the child's potential competence. Language delay or inattentiveness, for instance, may be caused by undiagnosed hearing loss. Yet nowhere is the student advised that there may be problems for which behaviour modification is not appropriate.

On page 164 one is relieved to read, " If the parent's expectations are deviant, the therapist must acquaint the parent with normative data on child behaviour." Where does the student acquire these, when even the authors' views on norms are questionable: systematic programmes are suggested to modify age old family frictions concerning closing doors, washing up, going to bed, homework, tidiness, brushing teeth? What is the effect on any child of having treatment, to which he must give his consent, for what most parents would consider normal, if irksome behaviour? When programmes are suggested for improving the frequency of kissing mother on her return from work, the mind boggles.

Ethical considerations are, in fact, discussed but usually parental consent and consensus about what behaviour is desirable are considered adequate safeguards. Yet what is the following statement doing in a beginners' manual—page 177— " Make the punishing stimulus as intense as possible while still causing no physical damage " ?

The authors are very systematic in describing methods, experimental designs and statistics, but there seems to be a basic confusion, at least to the uninitiated reviewer, between modifying undesirable social behaviour and teaching a new skill. No distinction is made between altering abnormal behaviour of multiple causation and meeting a cognitive deficiency. The prescriptions for improving reading and language, for instance, which involve modelling (i.e., example) verbal instructions and rewards (e.g., praise) in a one-to-one tutoring setting, are very similar to those used in a remedial teaching situation and the language of behaviour modification seems misleading. To the authors this distinction may not seem theoretically necessary; to most child psychologists one may require therapy, the other teaching, with very different connotations for the family.

In short, this book succeeds admirably in its aim of teaching the basic skills of behaviour modification, but its assumption that children can be used as suitable subjects for treatment without the need to have any previous knowledge of child development or family dynamics is regrettable, although, unfortunately, no longer uncommon in experimental psychology.

EVA HOLMES.

GHUMAN, P. A. S. (1975). *The Cultural Context of Thinking : A Comparative Study of Punjabi and English Boys.* Slough: N.F.E.R., pp. 136, n.p.

This slim monograph reports a comparative study of intellectual functioning of samples drawn from three different populations: schoolboys of English stock living in England ; schoolboys of Punjabi stock living in England, and schoolboys of Punjabi stock living in Punjab.

Traditional tests of conservation, Vygotsky Blocks, Progressive matrices and the Goodenough-Harris Draw-a-man tests have been used and these in conjunction with the results of teachers' assessments and of interviews pertaining to home background of the British Punjabi boys provide the data. The analysis of the data is said to show that the thinking processes of the English and British Punjabi boys are very similar and that this similarity is primarily due to educational experiences in English schools.

The monograph has the form of a thesis. It is, therefore, convenient to review it as such.

(*a*) *Review of previous work.* This is brief but does encompass the essential issues. It is, unfortunately, sometimes in error of fact and sometimes shows lack of critical acumen. A few examples will suffice. We are told (p. 22) that according to Witkin field dependence/independence " can be assessed by the use of . . . the Draw-a-man test, and the Block test." A thorough review of relevant literature provided by Witkin and Berry (1975) does not claim such simple relationship between the two tests. Lloyd's (1971) study comparing two groups of Nigerian children is adduced to support the view that Western-type environments are of importance to the growth of thinking processes, not withstanding the fact that this study not unlike other studies of the problem (e.g., Poole, whose work is quoted under the name of Pool), confounds probable differences in genetic endowment with environmental factors.

Similarly McFie's (1961) work is misrepresented in so far that it implies that he provided 'necessary background' experiences to his subjects which led to improvement of their performance on a block test. In fact, McFie's subjects were entrants to technical school (not a random sample of the population as one would imagine), who, on retesting after two years' training, were found to have gained significantly higher scores on non-language tests. Since no appropriate control group was used these results are merely suggestive. There are other lapses of this sort.

(*b*) *Research.* A mundane collection of tests is competently employed. In application of the techniques no reference is made to Bhatia's work on Kohs' blocks in India, and even more surprisingly, no account is taken of Ord's modification of the Pattern Reconstruction Test, which would have saved the indigenous Punjabis a lot of trouble and presumably facilitated inter-group comparisons.

It is odd that the author did not administer his questionnaire to the English schoolboys. He might have found, perhaps, that jigsaw puzzles were *more* common in the Punjabi homes than in the English homes of the same social stratum. However, this section is definitely better than the review.

(*c*) *Conclusions.* These extend beyond the evidence given. The data as they stand do *not* provide an unassailable proof that the difference in the responses of the two Punjabi groups are due to English schooling.

The results do not justify the global conclusions about the modifications to the system of schooling which the author puts forward.

JAN B. DEREGOWSKI.

GIBSON, J., and CHENNELLS, P. (Eds.) (1976). *Gifted Children: Looking to their Future*. London: Latimer, pp. 376, £5·00.

" The mother who heard her 4-year-old son, perched for the first time in the barber's chair, murmur ' B flat, Mummy ' when the electric clippers were switched on, knew she had a precocious son. How early can you spot this sort of thing? "

This story is taken from Brackenbury's account of the work of the Yehudi Menuhin School, one of 15 papers given at the first World Conference on Gifted Children held in London in 1975 and organised by the National Association for Gifted Children (UK). The proceedings of the conference are reported in this book, which includes as well as the main papers, a number given to small groups with reports of the discussions following them, and contributions from delegates from 25 countries under the title, " What my country does for gifted children." The papers and contributions vary in quality, some are disappointing, however, and the organisers did have a difficult task in providing for delegates with very different levels of knowledge about, and experience of, gifted children. At £5 a copy is it not possible to produce a paperback that remains flat when opened?

Parkyn makes a timely and scholarly plea for a broader view of giftedness. If we are concerned about the quality of life in our technological society then there is an urgent need to identify and foster the aesthetic awareness and ethical sensitivity of children; these kinds of gifts have been much less well developed than rational-scientific thinking.

The American contributors emphasise the importance of creativity in the identification and education of the gifted; Torrance considers it should be taught and suggests ways in which gifted pupils could be involved in studying the future and solving future problems. There is a description by Casey and Quisenberry of studies conducted in the United States of intellectually gifted pupils up to 8 years of age—and references are given. A Federal programme for the gifted and talented was launched in 1972; three years later Congress approved national expenditure of 2·5 million dollars for it for a year and gave authority to the Office of Education for the Gifted and Talented, directed by Lyon, to administer programmes for such children.

The possible extent of underachievement among gifted pupils in this country is indicated in a pilot study reported by Painter. She found that 72 per cent of the 73 children in her group were one year or less ahead of their mean classroom performance whereas the mean mental age of 13 years 4 months was 5 years above their mean chronological age of 8 years 4 months. In a preliminary report, Freeman, who is directing the Gulbenkian Research Project on Gifted Children, which includes 105 children aged 5 to 16 years, of NAGC members, states: " On the whole the children show normal behaviour in their family relationships, but they are particularly sensitive, persevering, emotional, and like to make up their own minds. Sleep is only a problem in early years or if parents see it as such." Information about the children in the two control groups being studied in the project is being analysed.

The reports concerning education in different countries range from provision such as that made in Israel, where a Department for Gifted Children in the Ministry of Education and Culture was established in 1972 and special classes set up, as well as post-elementary boarding schools for the able disadvantaged, to the situation in Denmark, where the Minister of Education has stated: " No child may be taught anything which exceeds the capacity of any one child in the class." The first alternative school for gifted children is now being started by parents.

As a result of this conference a World Council on Gifted Children has been formed, with a Secretariat in Washington, and a second world conference is being held at the University of San Francisco in the summer of 1977.

J. WILKS.

Hyman, H. H., Wright, C. R., and Reed, J. S. (1975). *The Enduring Effects of Education.* Chicago and London: Chicago University Press, pp. ix+313, £7·50.

This is an impressive research report, alike in content and presentation. The first third is a scientific, scholarly, stylish, condensed and critically argued discussion of the problem, the detailed methodology, and the findings of an exceedingly complex nation-wide investigation of the measurable cognitive effects of variable exposure to formal education in the USA. The rest of the book (some 200 pages) consists of a detailed tabulation of the survey materials employed and of the analysis of the data derived in the study.

The title begs a question to which every schoolboy from Yokohama to the Yukon, from Spitzbergen to The Cape might well, but mistakenly, assume that all teachers know the answer. In fact, the educational practitioners are at the mercy of the gales of philosophical, psychological, and sociological fashion, and are even now tossed upon a sea of noises and hoarse disputes about their objectives and their achievements. Even the solemn prophets of impending doom in Great Britain and the USA—Plowden, Coleman, Jencks—have been driven to base their discontentments upon highly dubious inferences about the outcomes of education at any or all levels. Researches upon the captive populations of educational institutions themselves are silent about the personal and social outcomes—some *in principle* capable of assessment—in the outside world in which the school leavers and the college graduates rub nostalgic shoulders.

Not politics alone is the art of the possible. The advancement of scientific knowledge also is cramped by the limitations of its instruments and its techniques and, in the human sciences, by the accessibility of sufficient and appropriate subjects for research. Facing the issue of post-graduation transfer of learning from elementary or high school or from college to the world of ordinary experience, Hyman and his colleagues confronted these practical problems. Norval Glenn and a few other investigators, concerned with trends over time in attitudes and behaviour, had already made successful use on a limited scale of the technique of ‘ secondary analysis.’ This circuitous parasitic ploy seemed to be the Hobson’s choice technique for investigating the long-term pay-off from schooling that had been completed from 10 to 40 years earlier. Starting from the proposition that “ to increase knowledge is a fundamental purpose of the entire educational enterprise ” the concern of Hyman’s team was to determine, with such quantification as might be possible, whether and to what extent this purpose had been achieved in a large unbiassed sample of the adult population of the USA. To this end the records of many existing surveys were available in the data banks. Conveniently, many of these surveys—by Gallup and others—had included questions, amounting sometimes to mini-tests, on areas of *knowledge*. These and the individual responses to them were recoverable, along with much relevant supporting documentation concerning the individual respondents, e.g., age, sex, level of education, class-status, and so on.

From surveys carried out between 1949 and 1971, a grand total of 54 were selected as meeting the requirements of the research and such that they provided (i) a total pool of about 80,000 individuals “ designed to approach . . . an unbiassed sample of the adult population,” and (ii) similar original records obtained at four periods in time—around 1951, 1956, 1963 and 1968—for four ‘ period ’ populations ranging from some 11,000 to 25,000. From the available human material there were excluded: (*a*) all persons below age 25, so that it could be assumed that virtually all those included had completed formal education; (*b*) all over age 72, so avoiding the attrition of significant numbers by institutionalisation or death; and (*c*) all non-white respondents to the original surveys, so circumventing the risk that comparisons might reflect ‘ racial ’ rather than age or educational differences. Hyman acknowledges that a consequence is that the worst deprivations affecting educational outcomes have not been explicitly tested, but the white samples did cover the full range of American schools, and individuals from all walks of life, both advantaged and disadvantaged. Four age-groups or life stages have been examined in each of the four historically clumped sets of surveys. These consist of adults aged 25 to 36; 37-48; 49-60; 61-72.

The investigators were concerned particularly with the responses to a total of 250 ' knowledge ' questions appearing sporadically across all the surveys and all the four periods. These questions could be categorised as dealing with (1) popular culture, (2) public affairs and (3) academic knowledge (i.e., history, humanities, geography, civics). More than half of the test-items are regarded as indicators of the individual's *receptivity* to further knowledge after his formal education has ended, since the question referred to matters about which he could not have learned at school: they had not happened! In addition, 50 items provide evidence of the individual's *seeking out* of new information.

It is impossible within reviewing limits even to outline the reticulated findings of this elaborated, ramifying study. But recalling its basic premise, quoted above, and calling attention to Hyman's explicit acknowledgment that cognition is not the only area of human development to which formal education has been expected to contribute, it is fair to set down their broad, general conclusion verbatim: " Many and varied measurements on thousands of adults, drawn from a long series of national samples, and thus representing the students taught in all the nation's schools and colleges over a long period, lead us to conclude that education produces large, pervasive and enduring effects on knowledge and receptivity to knowledge." So Hyman provides an answer to one of the most fundamental questions that can be asked about education. The massive array of his quantified evidence is convincing, though it cannot be expected to silence our noisy contemporary antinomians, nihilists, social activists, political doctrines, and ' de-schoolers.' But, as Coleman has handsomely acknowledged, it provides a landmark in research and points a way forward in the heaving darkness of our ignorance about the outcomes of educational effort and expenditure.

The book is profoundly stimulating and suggestive. It deserves a wide audience, far beyond that of the professional educators. Its enquiries have been pursued through the five decades of human maturity, and they have demonstrated that the positive effects of education endure at least until the seventh decade. That, as the authors say, " told us something about the power of education, but it also tells something about the powers of the aged. The picture of the aged, not highlighted before and possibly lost to sight, is certainly not one of an enfeebled group, detached from current affairs uninterested in stimulation, remote from popular culture." An emeritus reviewer will be content if he has provided a further crumb of evidence for their comforting assertion.

GEORGE SETH.

NORRIS, D. (1975). *Day Care and Severe Handicap.* London: N.S.M.H.C., pp. 47, 60p.

This booklet represents a slight addition to the extremely sparse literature on the care and education of the profoundly handicapped in this country. As any addition at all it is to be welcomed; however, the relative slightness of its contribution is to be regretted.

The problem with such booklets designed to highlight an area of special need is that neither their authors nor those who commission them, seem any too sure of the intended audience. On the one hand there must be the all too understandable desire to produce a document of academic respectability. Against this there is clearly the need to present a case that will be read and noted by those in a position to change the *status quo* ; anything too academic might be all too easily dismissed as indigestible or not positive enough in its recommendations. The prospective author is thus left in the difficult position of having to play both ends against the middle; the facts must be presented within a sound theoretical framework but in a way that emphasises the need for action. Since the studies involved almost invariably arise directly out of the expression of a felt need for action, there is the danger that the facts obtained will be stretched to meet those needs even where this is unwarranted.

The study under review highlights just these dangers. No one who is in any way conversant with the situation regarding the ' education ' of the adult severely subnormal in this country as a whole would be likely to consider it as much more than a disgrace, particularly as far as the profoundly handicapped are concerned. It is right, as David Norris says, that investigations should be carried out into just how much better the so-called 'special care' provisions are in adult training centres than in mental subnormality hospitals. However, a survey of five units attended by 81 ' clients ' cannot be said to be truly representative of the 40-plus units catering for those 1,500 or so profoundly retarded adults attending training centres and in need of special care, or even of the 600 or so at present receiving it.

The difficulty is further confounded by the fact that the units studied in the present sample clearly differ quite markedly along a number of dimensions. One striking fact, not remarked upon by Norris, is that one of the two units not purpose-built but containing almost twice the number of clients for which it was designed, was clearly providing by far the most stimulating and worthwhile schedule of activities (according to Norris's own criteria) at both a group and individual level for those in attendance. What, if anything, are we to make of this? Could it be that quality of teaching is far more important than architectural design? Unless we are given some criteria by which we can judge, there is unfortunately, no way in which such comparison can be made.

Norris makes great play of the need for prescriptive education for the severely mentally retarded, but makes no effort here to explain in any detail what he means by this, nor to present any sound theoretical basis for many of the recommendations that he makes with regard to various environmental and educational innovations. This is not to say that such innovations would be misguided—indeed, they mostly seem eminently sensible, but in terms of cost effectiveness one feels the need for a stronger theoretical basis for the demand for a larger slice of the nation's economic cake. It is quite clear that humanistic considerations alone have not been and will not prove to be the means whereby the lot of the severely mentally handicapped will be improved. There is a need to provide 'hard' evidence that radical changes in policy in line with Norris's recommendations regarding extra equipment, enhanced teacher/client ratios, in-service training, intensive support from other experts, improved salary scales, etc., will produce some kind of measurable improvement in the ability of clients and their families to achieve a greater measure of fulfilment and acceptability within the community than has hitherto has been the case. This David Norris does not do, nor, to be fair, could be reasonably be expected to do in a survey of this kind. Without such evidence, however, I fear that his demands will remain little more than pious hopes.

In conclusion, this is a document that is somewhat uneven in its approach and necessarily superficial in its discussion of many of the issues involved, but it is nonetheless stimulating in bringing many of these issues to light in an area that has hitherto suffered from far too much neglect.

R. L. BURDEN.

PUBLICATIONS RECEIVED

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NOTES TO CONTRIBUTORS

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The usual range of length of papers is from 2,500 to 4,000 words. Papers should be in a clear style and free from jargon. Statistical matter (formulae, tables, discussion of techniques, etc.) should be kept to a minimum, so that the *Journal* will be of interest to statistically untrained readers. Such concepts as mean, percentiles, standard deviations, correlation, chi-squared, standard error, critical ratio, significance and reliability, regression and factor analysis, can be employed in the text and need not be explained.

Short research notes will also be published, reporting work of two kinds : (i) results of sufficient moment to merit publication in advance of a more comprehensive paper ; (ii) work which substantially confirms or extends existing knowledge but which does not justify an extensive paper.

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3—Experimental reports should generally follow the standard pattern of presentation, e.g. :

(*a*) A short summary at the start.
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(*e*) Either a brief list of general conclusions, not repeating results already listed, or a discussion, which should be strictly limited to discussing the results (if this is necessary) and which should not involve mere recapitulation or speculation beyond the scope of the inquiry.
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4—The summary (which is often copied by abstracting agencies) should be intelligible without reference to the paper. It should give an indication of the aim, scope and results of the inquiry, preferably in about three sentences. It should mention the size and nature of the sample, and should not include vague phrases such as " The results were analysed . . . " or " The implications of the findings are discussed . . . " Even for a full-length paper, the summary should not exceed 200 words.

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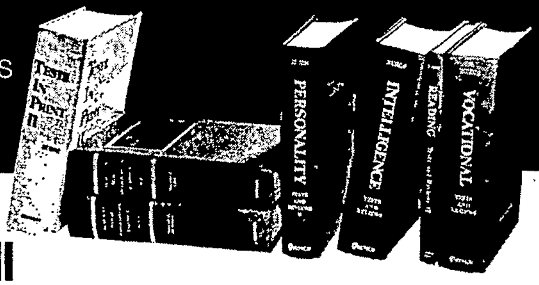

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